

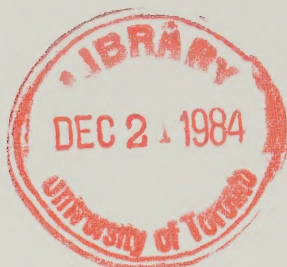


3 1761 11635801 1

Canadian
Coast GuardGarde côtière
canadienne

Code of Safe Practice for Solid Bulk Cargoes

**CODE OF
SAFE PRACTICE
FOR SOLID BULK CARGOES**



© Minister of Supply and Services Canada 1984

Available in Canada through

Authorized Bookstore Agents
and other bookstores

or by mail from

Canadian Government Publishing Centre
Supply and Services Canada
Ottawa, Canada K1A 0S9

Catalogue No: T31-27/1984E
ISBN 0-660-11735-5

Canada: \$7.50
Other Countries: \$9.00

Price subject to change without notice

FOREWORD

Millions of tonnes of solid bulk cargoes are shipped every year across the world's oceans. While the vast majority of these shipments are made without incident, there have unfortunately been serious casualties that resulted not only in the loss of ships, but also in loss of life.

This new Code is intended to set a standard for the safe stowage and carriage of solid bulk cargoes, excluding grain which is dealt with under the *Grain Cargo Regulations*. It supersedes the Canadian Bulk Cargoes Code of 1968, and incorporates the recommendations contained in the latest edition of the International Maritime Organization (IMO) Code of Safe Practice for Solid Bulk Cargoes, together with specific Canadian requirements especially as regards concentrates.

This Code is a recommended guide for shipowners, shippers and masters and shall apply to all shipments of bulk cargoes to which the relevant sections of the Canada Shipping Act apply, as well as the Acts respecting the Offices of Port Wardens in Quebec and Montreal. It sets the standards of "approved practice" and "proper stowage" as envisaged by these Acts.

The list of products appearing in the Appendices of the Code, however, is by no means exhaustive. Consequently, before any bulk cargo is loaded, it is essential to ascertain (normally from the shipper) the current physical and chemical properties of the cargo.

Individuals and organizations who feel that their acquaintance and experience with solid bulk cargoes may be of specific value, and could contribute to a general knowledge of the subject, are cordially invited to contribute their opinions to the Ship Safety Branch of the Canadian Coast Guard. Information relating to bulk cargoes that have proven hazardous is particularly welcome.

CONTENTS

Introduction

Section

1 - Definitions

2 - General precautions

Cargo distribution	2-1
Loading and unloading	2-2

3 - Trimming procedures

Bulk cargoes having an angle of repose equal to or less than 35 degrees	3-1
Bulk cargoes having an angle of repose greater than 35 degrees	3-1
Concentrates and other bulk cargoes possessing similar properties	3-1

4 - Safety of personnel

General requirements	4-1
Poisoning and asphyxiation hazards	4-1
Health hazards from dust	4-3
Flammable atmosphere	4-3
Ventilation systems	4-4
Grain under fumigation	4-4

5 - Methods of determining the angle of repose

Tilting box method	5-1
On board ship method	5-1
On site method	5-2

6 - Cargoes that may liquefy

Properties, characteristics and hazards	6-1
Precautions	6-2
Loading requirements	6-2
Specially suited ships	6-2
Submission of data	6-3
Exemptions	6-3

7 - The assessment of acceptability of consignments for safe shipment

Provision of information	7-1
Certificates of test	7-1
Sampling procedures	7-3
Frequency of sampling and testing for "flow moisture point" and "moisture content" determination	7-4

8 - Cargoes that may liquefy: test procedures

9 - Materials possessing chemical hazards

General requirements	9-1
Classes of hazard	9-1
Stowage and segregation requirements	9-2

10 - Stowage factor conversion tables

Appendixes

A - List of cargoes that may liquefy

- General
- Mineral concentrates
- Other materials

B - List of bulk materials possessing chemical hazards

C - List of bulk cargoes that are neither liable to liquefy (Appendix A) nor possess chemical hazards (Appendix B)

D - Laboratory test procedures, associated apparatus and standards (available on request from the Ship Safety Branch of the Canadian Coast Guard)

- D.1 Test procedures for cargoes that may liquefy and associated apparatus
- D.2 Test procedures to determine the angle of repose and associated apparatus
- D.3 Standards used in test procedures
- D.4 Self-heating test for charcoal

E - Sampling procedure for concentrates' stockpiles (available on request from the Ship Safety Branch of the Canadian Coast Guard)

F - Index of materials

INTRODUCTION

The primary aim of this Code is to promote the safe stowage and shipment of bulk cargoes by:

1. highlighting the dangers associated with the shipment of certain types of bulk cargoes;
2. giving guidance on the procedures to be adopted when the shipment of bulk cargoes is contemplated; and
3. describing test procedures to be employed to determine various characteristics of the bulk cargo materials.

In general, the hazards associated with the shipment of bulk cargoes may be considered to fall into the following categories:

1. Structural damage owing to improper distribution of the cargo

Section 2 provides advice on this subject.

2. Loss or reduction of stability during a voyage

This usually results from:

- a) a shift of cargo in heavy weather owing to the inadequate trimming or improper distribution of the cargo.

Sections 2, 3, and 5 provide advice on this subject.

- b) a shift to one side of the cargo space of cargoes that may flow as a liquid (thixotropic cargoes) under the stimulus of vibration and motion of a ship in a seaway. Such cargoes are normally finely grained materials, including fine coal, which are shipped containing excessive free moisture.

Sections 6, 8 and Appendix A provide advice on this subject.

3. Chemical reactions

Sections 4, 9 and Appendix B provide advice on the subject of the emission of toxic or explosive gases, oxidation, spontaneous combustion or severe corrosive effects.


Unless the properties of the material presented for shipment are available, it will be difficult to determine what precautions, if any, should be taken to ensure safe shipment. It is therefore essential that the *shipper provide adequate information* about the cargo to be shipped. Section 7 provides advice on this subject.

Section 4 gives special mention to the need for all personnel involved to exercise great care in preparing for, and during, loading or unloading bulk cargoes, and in particular when entering spaces that may be deficient in oxygen or contain toxic gases.

Appendices D and E provide details of test procedures and advice on methods of sampling to obtain representative samples for test purposes. They are available on request from the Ship Safety Branch of the Canadian Coast Guard.

The laboratory test procedures described are used for determining the following:

- a) the moisture content, flow moisture point and transportable moisture limit of materials that may liquefy;
- b) the angle of repose of granular material;
- c) self-heating test for charcoal.



Digitized by the Internet Archive
in 2023 with funding from
University of Toronto

<https://archive.org/details/31761116358011>

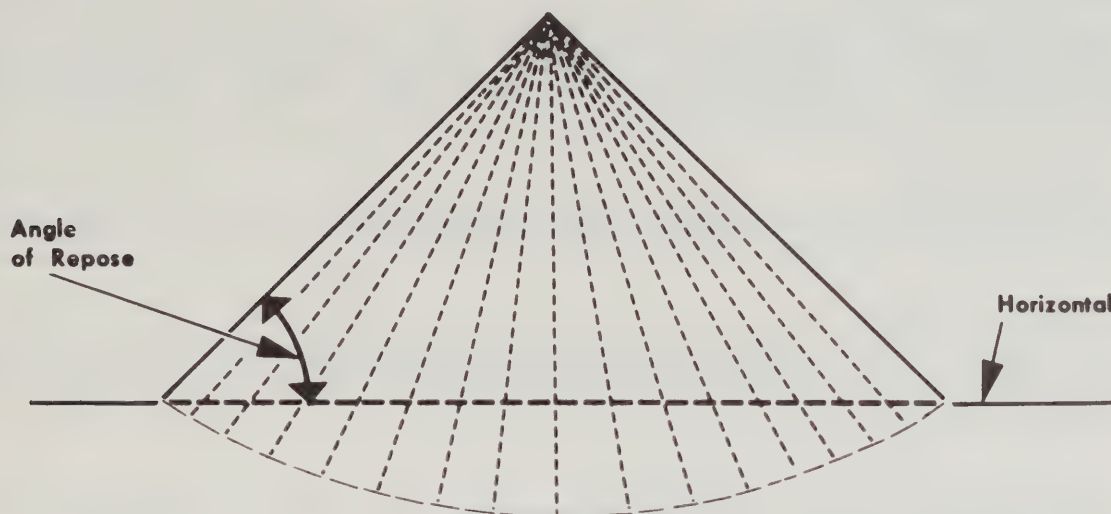
SECTION 1 — DEFINITIONS

1.1 “Administration”

— means the Government of the country in which the ship is registered or an agency representing such government.

1.2 “Angle of repose”

— is the angle between a horizontal plane and the natural cone slope of a pile of such loose (uncompacted) cargo.



1.3 “Cargo space”

— is any space in the ship appropriated for the carriage of cargo.

1.4 “Cargoes that may liquefy”

— are cargoes that are subject to moisture migration and subsequent liquefaction if shipped with a moisture content in excess of the transportable moisture limit.

1.5 “Concentrates”

— are minerals obtained from a natural ore by a process of purification by physical or chemical separation and removal of unwanted constituents.

1.6 “Degree of saturation”

— is the extent or degree to which the voids in the material contain water or ice. It is usually expressed as a percentage of the total void or pore space.

1.7 “Flow moisture point”

— is the percentage moisture content (wet weight basis) at which a flow state develops under the prescribed method of test in a representative sample of the material.

1.8 “Flow state”

— is a state that occurs when a mass of granular material is saturated with liquid to an extent that, under the influence of prevailing external forces such as vibration, impaction or ship's motion, it loses its internal shear strength and behaves as a liquid.

1.9 “General cargo vessel”

— is a vessel of the single deck type; or a vessel having one or more 'tween decks, whose holds run without interruption from shell plating to shell; or a vessel whose holds' sub-division by longitudinal bulkheads is insufficient to effectively restrain the bulk cargo from shifts capable of imperiling the vessel's stability and without special strengthening for heavy cargo.

1.10 “Incompatible materials”

— are those materials that may react dangerously when mixed. They are subject to the segregation requirements given in Section 9.3 and the individual entries of Appendix B.

1.11 “Moisture content”

— is that portion of a representative sample consisting of water, ice or other liquid ★ expressed as a percentage of the total wet weight of the sample.

1.12 “Moisture migration”

— is the movement of moisture contained in a bulk cargo caused by settling and consolidation of the cargo owing to vibration and ship's motion. Water is progressively displaced, which may result in some portions or all of the bulk cargo developing a flow state.

1.13 “Percent saturation (degree of saturation)”

— is the ratio expressed as a percentage of the volume of water or ice in a given bulk cargo to the total volume of permeable voids or intergranular space.

1.14 “Representative test sample”

— is a sample that retains the value of the characteristics desired of the whole mass within the required precision. It should be collected by an appropriate systematic sampling procedure and be of sufficient quantity to obtain the precision required and to meet the specific test requirements.

1.15 “Saturated”

— a sample of bulk cargo is saturated when all permeable voids between the grains are filled with liquid when the sample is at rest.

1.16 “Shipper”

— for the purposes of this Code, the term “Shipper” means any person by whom or in whose name or on whose behalf a contract of carriage of goods by sea has been concluded with a carrier, or any person by whom or in whose name or on whose behalf the goods are actually delivered to the carrier in relation to the contract of carriage by sea.

1.17 “Solid bulk cargo”

— is any cargo, other than liquid, gas or grain, consisting of a combination of particles, granules or any larger pieces of materials, generally uniform in composition, which is loaded directly into the cargo spaces of a ship without any intermediate form of containment.

1.18 “Stowage factor”

— the stowage factor of bulk cargo is the figure that expresses the number of cubic metres that one tonne of cargo will occupy.

1.19 “Transportable moisture limit”

— of cargo that may liquefy, represents the maximum moisture content of that cargo, which is considered safe for carriage in ships not complying with the special provisions of Section 6.4. It is derived from the flow moisture point and constitutes 90% of the value of the flow moisture point.

1.20 “Trimming”

— for the purpose of this Code, trimming means any levelling of the cargo within a cargo space, either partial or total, by loading spouts or chutes, portable machinery, equipment or manual labour.

1.21 “Thixotropic cargoes”

— refers to the property of these cargoes that enables them to stiffen after standing a relatively short time, but, upon agitation or manipulation, to change to a very soft consistency or as to a fluid of high viscosity; the process is completely reversible.

★ Procedures given in the Code apply only to the usual cases wherein the moisture consists almost entirely of free water or ice.

SECTION 2 — GENERAL PRECAUTIONS

2.1 Cargo distribution

2.1.1 General

2.1.1.1 It is important to ensure that bulk cargoes are properly distributed throughout the ship so that the structure will never be overstressed and the ship will have an adequate standard of stability. To do this effectively, however, the shipper must provide the master with adequate information about the cargo to be shipped, e.g. stowage factor, history of shifting, any particular problems, etc.

2.1.2 Preventing the structure from being overstressed

2.1.2.1 In the case of a high-density bulk cargo with a stowage factor of about 0.56 cubic metres per tonne or lower, the loaded conditions are different from those found normally and it is important to pay particular attention to the distribution of weight to avoid excessive stresses. A general cargo ship is normally constructed to carry cargoes of about 1.39—1.67 cubic metres per tonne when loaded to full bale cubic and deadweight capacity. Because of the high density of some bulk cargoes, improper distribution of loading, can greatly stress either the structure locally under the load or the entire hull. It is not practicable to set out exact rules for the distribution of loading in all ships since their structural arrangements may vary greatly. It is therefore recommended that the master be provided with sufficiently comprehensive loading information to enable him to arrange the loading aboard his ship so as not to overstress its structure. In general, masters should be guided by the loading information provided in the ship's stability information booklet and by the results obtained from loading calculators, if available.

2.1.2.2 When detailed information is not available for high-density bulk cargoes, the following precautions are recommended:

- the general fore and aft distribution of cargo by weight should not differ appreciably from that found satisfactory for general cargoes;
- the maximum number of tonnes of cargo loaded in any cargo space should not exceed 0.9 LBD tonnes (2.1.2.2.2)

where L = length of the hold in metres

B = average breadth of hold in metres

D = summer load draught in metres;

- where cargo is untrimmed or only partially trimmed, the corresponding height in metres of cargo pile peak above the cargo space floor should not exceed $1.1 \times D \times \text{stowage factor}$ (2.1.2.2.3)

where the stowage factor is given in cubic metres per tonne,

- if the cargo is trimmed entirely level, the maximum number of tonnes of cargo loaded in any lower hold cargo space may be increased by 20 per cent over the amount calculated by the formula (2.1.2.2.2), subject however to full compliance with 2.1.2.2.1;
- because of the stiffening effect of a shaft tunnel on the ship's bottom, lower hold cargo spaces abaft the machinery space may be loaded somewhat more deeply than provided in 2.1.2.2.2, 2.1.2.2.3 and 2.1.2.2.4, up to about 10 per cent excess, provided that such additional loading is consistent with 2.1.2.2.1.

2.1.3 Aiding stability

2.1.3.1 With regard to Regulation 19(a) of Chapter II-1 of the International Convention on Safety of Life at Sea, 1974, a stability information booklet should be provided aboard all ships subject to that Convention. Where bulk cargoes referred to in this Code, and requiring any of the loading and operational precautions specified therein, are to be carried, the information supplied to the master should include all necessary data relevant thereto. The master must be able to calculate the stability for the worst conditions anticipated during the voyage as well as that on departure, and show that the stability is adequate.

2.1.3.2 In general, high-density cargoes should normally be loaded in the lower hold cargo spaces rather than in 'tweendeck cargo spaces.

2.1.3.3 When, however, it is necessary to carry high-density cargoes in 'tween or higher cargo spaces, care must be exercised to ensure that the deck area is not overstressed and that the ship's stability is not reduced below the minimum acceptable level, as laid down in the ship's stability information booklet supplied to the master.

2.1.3.4 In transport of high-density cargo, a particularly careful evaluation should be made of the consequences of sailing with an excessively high GM with consequential violent movement in a seaway.

2.1.3.5 Shifting divisions and bins, of adequate strength, should be erected whenever bulk cargoes, which are readily capable of shifting, are carried in 'tweendeck cargo spaces or only partly fill a cargo space. Wooden shifting boards are not permissible for the transport of concentrates.

2.2 Loading and unloading

2.2.1 Before loading, the cargo spaces should be inspected and prepared for the particular bulk cargo to be loaded.

2.2.2 The master should ensure that bilge lines, sounding pipes and other service lines within the cargo space are in good order. Because of the velocity at which some high density bulk cargoes are loaded into the cargo space, special care may be necessary to protect cargo space fittings from damage. For this reason it is prudent to sound bilges after the completion of loading.

2.2.3 Attention is drawn particularly to bilge wells and strainer plates, which should be specially prepared to facilitate drainage and prevent entry of the cargo into the bilge system.

2.2.4 The master is advised that precautions should be taken to minimize the extent to which dust may come into contact with the moving parts of deck machinery and external navigational aids.

2.2.5 Wherever possible, ventilation systems should be shut down or screened and air conditioning systems, if any, placed on recirculation during loading or discharge, to minimize the entry of dust into the living quarters or other interior spaces of the ship.

SECTION 3 — TRIMMING PROCEDURES

3.1 Bulk cargoes having an angle of repose ★ equal to or less than 35 degrees

3.1.1 Such cargoes should be trimmed reasonably level and cargo spaces in which they are loaded should be filled as fully as practicable without resulting in an excessive cargo weight on the supporting bottom structure or deck.

3.1.2 Where dry bulk cargoes that flow freely like grain are to be carried, the provisions applicable to the stowage of grain cargoes should be followed. Account should be taken, however, of the density or unit weight of the cargo when determining:

1. the scantlings and securing arrangements of divisions and bin bulkheads; and
2. the stability effect of free cargo surfaces.

3.2 Bulk cargoes having an angle of repose ★ greater than 35 degrees

3.2.1 When cargo is loaded only in lower cargo spaces, it should be trimmed sufficiently to cover the entire tank top out to the ship's side, and otherwise as necessary to reduce the pile's peak height and equalize the weight distribution on the bottom structure.

3.2.2 Such trimming as is necessary may generally be accomplished by levelling within the hatch square (see 3.2.3), with the remaining cargo sloped approximately uniformly to the lower cargo space sides, and to the end bulkheads. Provided that there is no conflict with the *Load Line Regulations* or the 1966 Load Line Convention, and if an excessive peak height does not result, cargo may extend up through the 'tweendeck hatchway, which should then be left uncovered. In such case, the pile should be sufficiently clear of the hatchway edges so that any possible slide of the pile's peak will remain in the cargo space.

3.2.3 Notwithstanding the above, or the provisions in Section 2, the importance of trimming can never be overstressed as an effective means of reducing the possibility of a shift of cargo. This advice applies especially to smaller ships, i.e. 100 metres long or less. Consequently the loading of smaller ships requires careful supervision. In such ships the aim should be to distribute the cargo so as to eliminate the formation of wide, steeply sloped voids beyond the trimmed surface within the area of the hatch square.

3.2.4 In any ship where it is necessary to load cargo in the 'tweendecks, the 'tweendeck hatch should be closed. The 'tweendeck cargo should be trimmed reasonably level and should either extend from side to side and bulkhead to bulkhead, or be secured in bins. Because of the reduced stability when cargo is carried in the 'tweendecks, it is generally necessary for the cargo in the lower hold to be trimmed to a greater extent than when cargo is carried only in the lower cargo space.

3.3 Concentrates and other bulk cargoes possessing similar properties

3.3.1 The importance of trimming concentrate cargoes cannot be overestimated as an effective measure to reduce both shifting of the cargo and the effects of oxidation (see 6.1.5).

3.3.2 Concentrates shall be trimmed reasonably level, loaded so as to reach all boundaries of each compartment and levelled within the square of the hatch so that the height differences between peaks and troughs do not exceed 5% of the ship's breadth. The cargo shall slope uniformly from the hatch boundaries to the bulkheads and no shearing faces should remain to collapse during the voyage.

3.3.3 When concentrates are loaded that have a moisture content in excess of the transportable moisture limit, the whole surface area of each cargo space shall be trimmed level.

★ Refer to Section 5 for recommended methods of determining the angle of repose.

SECTION 4 — SAFETY OF PERSONNEL

4.1 General requirements

4.1.1 Before and during loading, transport and unloading of bulk cargoes, all necessary safety precautions including any regulations or requirements should be observed, including the following:

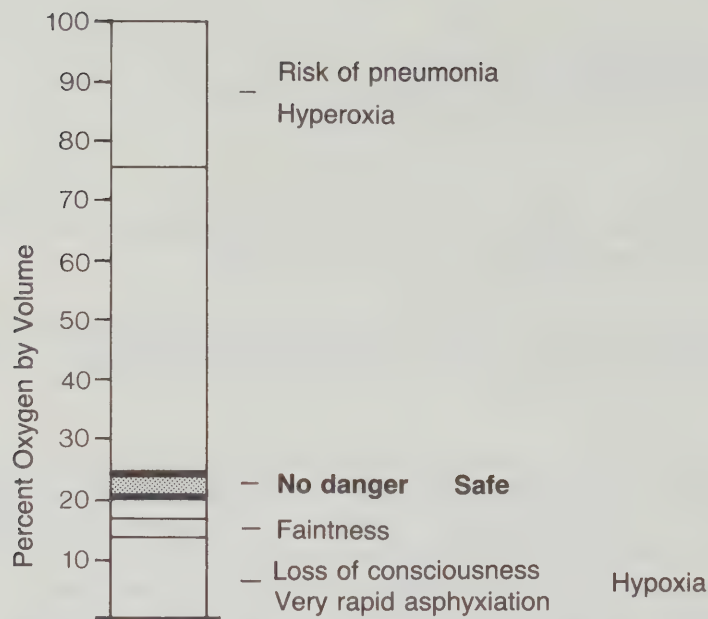
1. Dangerous Bulk Material Regulations
2. Safe Working Practices Regulations
3. International Maritime Dangerous Goods Code
4. Emergency Procedures For Ships Carrying Dangerous Goods
5. Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG)

4.2 Poisoning and asphyxiation hazards

4.2.1 Certain bulk cargoes are liable to oxidation, which in turn may result in oxygen depletion, emission of toxic fumes and self-heating. Other bulk cargoes may not oxidize but may emit toxic fumes.

4.2.2 It is important therefore that the shipper inform the master before loading of the existence of any chemical hazards. The master should refer to Appendix B and take the necessary precautions, especially those pertaining to ventilation.

4.2.3 Ships' masters are warned that cargo spaces and adjacent spaces may be depleted of oxygen or may contain toxic or asphyxiating gases. This may be due to oxidation, other chemical reactions or the evolution of contained gases. An empty cargo space that has remained closed for some time may have insufficient oxygen to support life. Oxygen accounts for 21% by volume of the air we breathe, the remainder consisting of nitrogen, argon, etc. Entry into a space without self-contained breathing apparatus should not be permitted unless there is a minimum of 20% and a maximum of 23% oxygen present. Serious consequences can result from entry into oxygen-depleted atmospheres (less than 17% oxygen by volume), and death by asphyxiation can result if the oxygen content becomes excessively low (less than 12% by volume). The following table summarizes the physiology of oxygen at atmospheric pressure.



This table should be treated cautiously as the limits vary for different individuals.

4.2.4 Unless adequate ventilation and air circulation throughout the free space above the cargo have been effected, personnel should not be permitted entry until tests have been carried out, and it has been established that the oxygen content has been restored to normal levels throughout the space and that no toxic gas is present. Instruments are available to determine the degree to which cargo spaces may be depleted in oxygen content or may contain toxic or asphyxiating gases. Some measure oxygen content only, whereas others can measure both oxygen and combustible gas levels. Most toxic gas concentrations are determined using a specific instrument as the gas type must be known and matched with an appropriate detector tube. A competent authority must have approved any instrument used.

4.2.5 Certain cargoes may emit toxic gases when wetted. In these cases the ship should be provided with the appropriate gas detection equipment (see 4.2.4).

4.2.6 A flammable gas detector is only suitable for testing the explosive nature of gas mixtures.

4.2.7 Emergency entry into a cargo space should be undertaken only by trained personnel wearing self-contained breathing apparatus, and protective clothing if considered necessary, always under the supervision of a responsible officer.

4.2.8 In the event of emergency entry into a cargo space, in addition to the requirement in 4.2.4, spare self-contained breathing apparatus, safety belts and safety lines should be readily available.

4.3 Health hazards from dust

4.3.1 To minimize the chronic risks from exposure to the dust of certain materials carried in bulk, a high standard of personal hygiene for those exposed to the dust cannot be too strongly emphasized. The precautions should include not only the use of appropriate protective clothing and barrier creams when needed but also adequate personal washing especially before meals, and laundering of outer clothing. Although these precautions are good standard practice, they are particularly relevant in the presence of those materials identified as toxic by the Code.

4.4 Flammable atmosphere

4.4.1 Dust created by certain cargoes may constitute an explosion hazard, especially during loading, unloading and cleaning. This risk can be minimized at such times by ensuring that ventilation is sufficient to prevent the formation of a dust-laden atmosphere and by hosing down rather than sweeping.

4.4.2 Some cargoes may emit flammable gases in sufficient quantities to constitute a fire explosion hazard. Where this is indicated in the entries in Appendix B, the cargo spaces and adjacent enclosed spaces should be effectively ventilated at all times. It may be necessary to use combustible gas indicators to monitor the atmosphere in such spaces. In general, combustible gas measuring instruments are not suitable for checking an atmosphere for the presence of toxic gases.



4.5 Ventilation systems

4.5.1 Where cargoes are carried that may emit toxic or flammable gases, the cargo spaces should be provided with effective ventilation.

4.6 Grain under fumigation

4.6.1 In-transit fumigation of grain cargoes is not permitted on Canadian ships.

4.6.2 In-transit fumigation of grain cargoes will only be permitted on bulk carriers and tankers subject to written approval being received from the flag Administration.

4.6.3 Fumigation of grain cargoes shall be performed in accordance with the latest version of the IMO Recommendations on the Safe Use of Pesticides in Ships. A copy of these Recommendations for use by ships' personnel shall be on board each ship undergoing in-transit fumigation.

SECTION 5 — METHODS OF DETERMINING THE ANGLE OF REPOSE

5.1 Various methods are in use to determine the angle of repose for bulk materials, several of which are listed below.

5.1.1 For ores, coals and ore concentrates the angle of repose should always be determined in the condition in which the material is to be loaded.

5.2 Tilting box method

5.2.1 This method was developed mainly for laboratory use and is suitable for non-cohesive granular materials having a grain size not greater than 10 mm. Appendix D.2, which is available on request from the Ship Safety Branch of the Canadian Coast Guard, provides a full description of the equipment and procedure.

5.3 On board ship method

5.3.1 On board ship, the following auxiliary method can be used with non-cohesive granular materials having a grain size not greater than 10 mm. Results thus obtained, however, are generally lower than those obtained by the tilting box method.

5.3.2 Definition

According to this method the angle of repose is the angle between the cone slope of the loose material and the horizontal measured at half height.

5.3.3 Principle of test

To determine the angle of repose, a quantity of the material to be tested is carefully poured out of a flask onto a sheet of rough-textured paper, so that a symmetrical cone forms.

5.3.4 Equipment

The equipment necessary to carry out this test is:

- a horizontal table free from vibrations;
- a sheet of rough-textured paper onto which the material can be poured;
- a protractor;
- a 3-litre conical flask.

5.3.5 Procedure

Place the sheet of paper on the table. Divide 10 dm³ of the material to be tested into three sub-samples and test each in the following way:

Pour two-thirds of the sub-sample (i.e. 2 dm³) onto the sheet producing a starting cone. Carefully pour the remainder of this sub-sample on top of the cone from a height of a few millimetres above the cone. Take care that the cone is built up symmetrically, by slowly revolving the flask close around the top of the cone while pouring. When measuring take care that the protractor does not touch the cone; otherwise this may result in sliding of the material and spoil the test. Measure the angle at four places around the cone, about 90° apart. Repeat this test with the other two sub-samples.

5.3.6 Calculations

The angle of repose is taken as the mean of the twelve measurements and is reported to an accuracy of half a degree. This figure can be converted to the tilting box value as follows:

$$a_t = a_s + 3^\circ \text{ (5.3.6.1)}$$

where a_t = angle of repose according to the tilting box test,

a_s = angle of repose according to the survey test.

5.4 On site method

5.4.1 This method may be used to determine the angle of repose for all bulk materials when a stockpile of the material to be loaded is available. The angle subtended by the surface of the stockpile and the ground is measured (see sub-section 1.2). A minimum of six such measurements should be taken around the circumference of the stockpile and the mean of these measurements will provide the angle of repose. Where a stockpile is not available, a cone of the material as deposited by grab, truck or similar means may be utilized. The larger the cone so obtained, the more accurately the angle of repose will equate with the on board situation.

5.4.2 Where masters are in doubt as to the method that should be, or has been, used, they should consult the appropriate port authority for advice.

SECTION 6 — CARGOES THAT MAY LIQUEFY

6.1 Properties, characteristics and hazards

6.1.1 Cargoes that may liquefy include concentrates, certain coals and other materials having similar physical properties. Appendix A contains a list of such cargoes, which generally consist of a mixture of small particles in contrast with natural ores that include a considerable percentage of large particles or lumps.

6.1.2 At a moisture content above that of the transportable moisture limit, shift of cargo may occur as a result of liquefaction.

6.1.3 The major purpose of the sections of this Code dealing with these cargoes is to draw the attention of masters and others to the latent risk of cargo shift, and to describe the precautions deemed necessary to minimize this risk. Such cargoes may appear to be relatively dry and granular when loaded, but may contain sufficient moisture as to become fluid under the stimulus of compaction and the vibration that occurs during a voyage.



6.1.4 In the resulting viscous fluid state, cargo may flow to one side of the ship when it rolls one way, but not completely return when it rolls the other. Thus, the ship may progressively reach a dangerous heel and capsize.

6.1.5 To prevent subsequent shifting, and also to decrease the effects of oxidation of material with a predisposition to oxidize, these cargoes should be trimmed reasonably level on completion of loading, irrespective of the stated angle of repose (See 3.3).

6.2 Precautions

6.2.1 Adequate precautions to prevent liquids entering the cargo space in which these cargoes are stowed should be maintained during the voyage. Such precautions are of paramount importance for some of these cargoes where contact with sea water could lead to serious problems or corrosion to either the hull or machinery items.

6.2.2 Masters are cautioned about the possible danger in using water to cool a shipment of these cargoes while the ship is at sea, since the admission of water in quantity may well bring the moisture content of these cargoes to a flow state. Water is most effectively applied as spray.

6.3 Loading requirements

6.3.1 Section 614(4) of the *Canada Shipping Act* states:

“The master or agent of any ship intending to load concentrates consigned to any place outside Canada and not being a place within the limits of an inland voyage shall make application to the port warden, who shall survey and approve stowage according to approved practice, when the quantity of concentrates proposed to be carried exceeds eighteen per cent of the total cargo-carrying capacity of the ship; and the port warden shall enter in his books a statement showing the manner of stowage and securing, and issue a certificate accordingly.”

The loading of concentrates and similar materials is therefore subject to routine survey and certification before the ship in which they are carried puts out to sea; this Code will be considered to set the standards of “approved practice” as envisaged by the Act.

6.3.2 Ships other than specially suited ones (see 6.4) shall carry only those cargoes having a moisture content that is not in excess of the transportable moisture limit as defined in this Code.

6.3.3 Cargoes having a moisture content in excess of the flow moisture point shall not be carried in bulk.

6.3.4 Cargoes that contain aqueous liquid, other than packaged canned goods or the like, shall not be stowed in the same cargo space above or adjacent to a consignment of these cargoes. This category includes logs that are loaded directly from the water and other cargoes covered with ice or snow.

6.3.5 Loading of concentrates shall be suspended during continuous or heavy rain or snow and the cargo spaces' hatches are to be closed.

6.4 Specially suited ships

6.4.1 Specially suited ships may carry concentrates having a moisture content in excess of the transportable moisture limit if the ship possesses a valid document of approval from her administration, accompanied by such stability information as her administration may require. The document of approval must clearly state “For carriage of concentrates having a moisture content in excess of the transportable moisture limit.”

6.4.2 Such a ship shall possess a statement from her Administration or load line Assigning Authority indicating her structural suitability for the carriage of such cargoes.

6.4.3 The Ship Safety Branch of the Canadian Coast Guard may similarly approve a ship upon request of the ship's national Administration.

6.4.4 In any event, to be allowed to carry concentrates having a moisture content in excess of the transportable moisture limit, the ship shall prove compliance with the stability requirements (see 6.5.1).

6.5 Submission of data

6.5.1 When the Canadian Coast Guard is requested to approve a ship to carry concentrates having a moisture content in excess of the transportable moisture limit, such request shall be accompanied by:

- a) scale longitudinal and transverse section drawings together with relevant structural drawings;
- b) a statement from the ship's load line Assigning Authority confirming that she is structurally suitable for the carriage of such cargoes and indicating the maximum quantity that may safely be loaded in any cargo space;
- c) a stability information booklet indicating that the ship has sufficient stability to cope with an assumed shift of the concentrate cargo to 20° from the horizontal when carrying a full normal service load of concentrate. The stability shall be deemed adequate, if at every stage of the intended voyage:
 - 1) The angle of heel due to shift of cargo shall not exceed 65% of the angle at which the deck edge immerses in still water.
 - 2) Residual dynamic stability measured to 30° beyond the angle of heel is not less than 0.10 metre radians.
 - 3) Heeling moments of other cargo aboard the ship which is liable to shift shall be taken into account;
- d) any other information that may assist assessment of the submission.

6.6 Exemptions

6.6.1 When engaged upon a regular specific trade, ships in possession of valid documents of approval may be authorized to load without the direct supervision of a port warden. Such authorization, will be issued subsequent to the approval documents detailed in 6.4.1 and 6.4.2, after inspection by the Canadian Coast Guard, and provided that the original approval is for a vessel to carry a full cargo of concentrates having a moisture content in excess of the transportable moisture limit.

6.6.2 In this case, the port warden shall be present during the first occasion of loading. If the loading method remains unchanged and the ship stays in regular employment in such trade, the port warden may endorse the certificate for a specially built ship approved for the carriage of concentrates from Canadian ports, issued under section 614(4) *Canada Shipping Act*, approving the stowage for future similar voyages. The validity of this certificate shall be one year from the date of issue. The port warden shall retain the right to spot check loading procedures during this period, but shall not charge a fee for such inspections unless he is required to intervene.

6.6.3 Nothing shall interfere with the provisions of section 616 of the Canada Shipping Act concerning the final certification of the ship as being fit to proceed to sea after having loaded concentrates.

SECTION 7 — THE ASSESSMENT OF ACCEPTABILITY OF CONSIGNMENTS FOR SAFE SHIPMENT

7.1 Provision of information

7.1.1 Before shipment, the shipper shall provide details regarding the nature of the cargo.

7.1.2 Before loading, the shipper or his appointed agents shall provide to the master and the port warden, if requested, details, as appropriate, of the characteristics and properties of any material constituting bulk cargo, such as flow moisture point, stowage factor, moisture content, angle of repose, chemical hazards, etc. so that any necessary safety precautions can be put into effect.

7.1.3 To do this the shipper shall arrange, possibly in consultation with the producers, for the cargo to be properly sampled and tested. Furthermore, the shipper should provide the ship's master and the port warden, if requested, with the appropriate certificates of test, as applicable for a given cargo.

7.2 Certificates of test

7.2.1 A certificate(s), stating the relevant characteristics of the material to be loaded, should be provided at the loading point to the master and the port warden, if requested.

7.2.2 Certificates of moisture content shall state, or be accompanied with a statement by the shipper, that the moisture content specified in the certificate of analysis is, to the best of his knowledge and belief, the average moisture content of the cargo at the time the certificate is presented to the master. When cargo is to be loaded into more than one cargo space of a ship the certificate of moisture content shall certify the moisture content of each type of finely grained material loaded into each cargo space. If sampling according to the approved procedures recommended in this Code, however, indicates that the moisture content is uniform throughout the consignment, then one certificate of average moisture content for all cargo spaces shall be acceptable. Figure 7.1 is a recommended format of a Certificate of Analysis required to comply with this requirement.

CERTIFICATE OF ANALYSIS

Date _____

We hereby certify that we have sampled and analysed the cargo described and report as follows:

Cargo _____ concentrates in stockpile

Earmarked for loading on the _____

Date sampled _____

Stockpile located at _____

We drew samples from various points of the stockpile described above, earmarked for loading to designated vessels,
as of _____

An average composite sample was prepared and dried to constant weight.

Total moisture in % is _____

Transportable moisture limit in % is _____

This transportable moisture limit was determined in accordance with the method described in the Code of Safe
Practice for Solid Bulk Cargoes on _____

The samples used to determine these results were obtained by sampling methods at least equal to those
recommended by the Canadian Coast Guard.

Signature and Title

Copies: Master of vessel
Port warden
Any other officials

Figure 7.1

7.2.3 Where Appendix B requires certification for materials possessing chemical hazards, the certificate should contain, or be accompanied by, a statement from the shipper that the chemical characteristics of the material are, to the best of his knowledge, those existing at the time of the ship's loading.

7.3 Sampling procedures

7.3.1 It is evident that any physical property tests on the bulk cargo material will be meaningless unless they are conducted on test samples established as truly representative of the consignment, before loading.

7.3.2 Sampling should be conducted only by persons suitably trained in sampling procedures and who are under the supervision of someone who is fully aware of the properties of the material and also the applicable principles and practices of sampling.

7.3.3 Before samples are taken, and within the limits of practicability, a visual inspection should be carried out of the material that is to form the ship's cargo. Any substantial portions of material that appear to be contaminated or significantly different in characteristics or moisture content from the bulk of the consignment should be sampled and analyzed separately. Depending upon the results obtained in these tests, it may be necessary to reject as unfit for shipment those particular portions.

7.3.4 Representative samples should be obtained by employing techniques that take the following factors into account:

- the type of material;
- the particle size distribution;
- composition of the material and its variability;
- the manner in which the material is stored, i.e. in stockpiles, rail wagons or other containers, and transferred or loaded by material handling system such as conveyors, loading chutes, crane grabs, etc.;
- the characteristics to be determined: moisture content, flow moisture point, bulk density/stowage factor, angle of repose etc.;
- variations in moisture distribution throughout the consignment, which may occur owing to weather conditions, natural drainage (e.g. to lower levels of stockpiles or containers) or other forms of moisture migration.

7.3.5 Throughout sampling procedures, the utmost care should be taken to prevent changes in quality and characteristics. Samples should be immediately placed in suitable containers that must be sealed and properly marked.

7.3.6 The Canadian Coast Guard has established a standard sampling procedure for sampling open stockpiles. It is described in Appendix E, which is available on request from the Ship Safety Branch of the Canadian Coast Guard. Any samples of concentrate must be taken by such method or its equivalent, and certificates of analysis shall be endorsed in the following manner: "The samples used to determine these results were obtained by sampling methods at least equal to those recommended by the Canadian Coast Guard."

7.4 Frequency of sampling and testing for “flow moisture point” and “moisture content” determination

7.4.1 A competent independent laboratory shall at regular intervals conduct a test to determine the “flow moisture point” of cargoes that may liquefy. This test shall be conducted at least once every six months, even for materials of consistent composition. Where the composition or characteristics are variable for any reason, more frequent testing is necessary. In such cases, testing at least once every three months, and possibly more frequently, is essential as such variations could have a significant effect on the value of the flow moisture point. In certain cases it will be necessary to test every shipment. The concentrate producer shall provide a copy of the certificate of analysis from the laboratory to the Canadian Coast Guard, and, at the time of shipment, to the port warden at the loading port.

7.4.2 Sampling and testing for “moisture content” should be conducted as near as possible to the time of loading, but, in any event, the time interval between sampling/testing and loading should never be more than seven days, unless the consignment is adequately protected to ensure no increase in its moisture content. Furthermore, whenever there has been significant precipitation between the time of taking samples from a stockpile exposed to the weather and the time of loading, further representative samples shall be taken and analysed for moisture content before loading. A qualified chemist or laboratory shall conduct these analyses.

7.4.3 Where the stockpile is situated at a place remote from the berth and shipment is made from the stockpile by rail, road or barge for direct loading into the ship, representative samples taken from the stockpile may be used if the cargo has not been exposed to rain or other wetting during transfer from stockpile to ship. Similarly, a concentrate to be loaded from railway cars, trucks or barges should be adequately protected.

7.4.4 Where the cargo is known to have been wetted during transfer or is held in trucks, railcars, or barges for some time before loading, representative samples shall be taken before loading from approximately one truck in every five, or the equivalent in railcars or barges, at the surface and at half depths.

SECTION 8 — CARGOES THAT MAY LIQUEFY: TEST PROCEDURES

8.1 Appendix D gives the recommended test procedures for the laboratory determination of:

- the moisture content of representative samples of the cargo to be loaded;
- the flow moisture point and the transportable moisture limit of the cargo.

8.2 Before and during loading, auxiliary check tests of the moisture content may be carried out using instruments designed specifically for that purpose, such as the "SPEEDY MOISTURE TESTER". Tests conducted with this instrument indicate a precision of $\pm 1\%$ compared with the laboratory method, i.e. with a laboratory reading of 10%, the "SPEEDY" reading could range from 9% to 11%. If the readings obtained by this method are consistently higher than those shown on the certificate (see 7.2.2), loading of the cargo should cease and a further laboratory test be conducted.

8.3 If the master has doubts as regards the appearance or condition of the cargo for safe shipment, the following auxiliary method may be used on board ship or at the dockside to perform a check test for approximately determining the possibility of flow:

8.3.1 Half fill a cylindrical can or similar container (0.5-1 litre capacity) with a sample of cargo. Take the can in one hand and bring it down sharply from a height of about 0.2m to strike a hard surface such as a solid table. Repeat the procedure twenty-five times at one or two second intervals. Examine the surface for free moisture or fluid conditions. If free moisture or a fluid condition appears, make arrangements to have additional laboratory tests on the cargo conducted before it is accepted for loading.

8.4 The recommended test procedures given in Appendix D reflect the majority opinion of those countries having participated in its preparation. However, other methods may be used which have been approved by the appropriate authorities as being equally reliable.

SECTION 9 — MATERIALS POSSESSING CHEMICAL HAZARDS

9.1 General requirements

9.1.1 Appendix B lists solid materials transported in bulk, which because of their chemical nature or properties can present a hazard during transport. Some of these materials are classified as dangerous goods in the International Maritime Dangerous Goods (IMDG) Code; also included are other materials that, when transported in bulk, may give rise to a hazardous situation.

9.1.2 This list of materials is by no means exhaustive. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain currently valid information about its physical and chemical properties before loading. For materials possessing chemical hazards falling within the classification of 9.2.2 and not listed in Appendix B, the ship concerned should carry evidence of approval for their transport from the competent authority.

9.1.3 Where consultation with the competent authority is required before bulk shipment of a material, it is equally important to consult authorities at the ports of loading and discharge concerning requirements that may be in force.

9.2 Classes of hazard

9.2.1 The classification of materials possessing chemical hazards that are intended for bulk shipment under the requirements of this Code should be in accordance with 9.2.2 and 9.2.3.

9.2.2 Classification

Chapter VII of the International Convention for the Safety of Life at Sea 1974 sets out the various classes of dangerous goods. For the purpose of this Code, it is more convenient to designate these classes in accordance with the IMDG Code and to define in greater detail the materials that fall within each class. Additionally, “materials hazardous only in bulk” (MHB) are defined in this Section.

9.2.2.1 Class 4.1: Flammable materials

These materials possess the properties of being easily ignited by external sources such as sparks and flames and of being readily combustible or liable to cause or contribute to fire through friction.

9.2.2.2 Class 4.2: Materials liable to spontaneous combustion

These materials possess the common property of being liable to heat spontaneously and ignite.

9.2.2.3 Class 4.3: Materials which, in contact with water, emit flammable gases

These materials possess the common property, when in contact with water, of evolving flammable gases. In some cases these gases are liable to spontaneous ignition.

9.2.2.4 Class 5.1: Oxidizing materials (agents)

These materials although in themselves not necessarily combustible may, either by yielding oxygen or through similar processes, increase the risk and intensity of fire in other materials with which they come into contact.

9.2.2.5 Class 6.1: Poisonous (toxic) materials

These materials are liable to cause death, serious injury or to harm human health if swallowed or inhaled, or by skin contact.

9.2.2.6 Class 6.2: Infectious materials

These materials contain viable micro-organisms or their toxins, which are known or suspected to cause disease in animals or humans.

9.2.2.7 Class 7: Radioactive materials

These materials emit significant radiation of which the specific activity is greater than 0.002 microcurie per gramme.

9.2.2.8 Class 8: Corrosive materials

These materials in their original state possess the common property of being able more or less severely to damage living tissue.

9.2.2.9 Class 9: Miscellaneous dangerous materials

These materials present a danger not covered by other classes.

9.2.3 Materials hazardous only in bulk (MHB)

These materials are not listed in the IMDG Code. When carried in bulk, they present sufficient hazards to require specific precautions. For example, materials that reduce the oxygen content of a cargo space and those that are prone to self-heating are regarded as belonging to this group.

9.3 Stowage and segregation requirements

9.3.1 General requirements

9.3.1.1 The potential hazards of the materials listed in Appendix B, and falling within the classification of 9.2.2 and 9.2.3, entail the need for segregation of incompatible materials.

9.3.1.2 In addition to general segregation as between whole classes of materials, there may be a need to segregate one particular material from others that would contribute to its hazard. In the case of segregation from combustible materials, this would not include packaging material, ceiling or dunnage; the latter should be kept to a minimum in these circumstances.

9.3.1.3 For the purpose of segregating incompatible materials, the words "hold" and "compartment" are deemed to mean any cargo space enclosed by steel bulkheads or shell plating, and by steel decks. The boundaries of such a space should be resistant to liquid and fire.

9.3.1.4 When two or more incompatible materials are to be transported in bulk, the segregation between them should be at least equivalent to that described under "Separated from" (see 9.3.4).

9.3.1.5 Where different grades of material are transported in bulk in the same cargo space, the most stringent segregation provisions applicable to any of the different grades should apply to all of them.

9.3.1.6 When materials in bulk and dangerous goods in packaged form are to be transported, the segregation between them should be at least equivalent to that described in 9.3.3.

9.3.1.7 Incompatible materials should not be handled simultaneously. In particular contamination of foodstuffs should be avoided. Once loading of one such material is completed, the hatch covers of every cargo space containing that material should be closed and the decks cleaned of residue before loading of other materials commences. When discharging, the same procedures should be followed.

9.3.1.8 To avoid contamination, a material indicated as toxic should be stowed "Separated from" all foodstuffs (see 9.3.4).

9.3.1.9 Material that may evolve toxic gases in sufficient quantities to affect health should not be stowed in those spaces from where such gases may penetrate into living quarters, work areas, or ventilation systems.

9.3.1.10 After discharge of a material for which toxicity is indicated, spaces used for its transport should be inspected for contamination. A space that has been contaminated should be properly cleaned and examined before being used for other cargoes, especially foodstuffs.

9.3.1.11 After discharge of materials, a close inspection should be made for any residue, which should be removed before the ship is presented to receive other cargo.

9.3.2 Special requirements

9.3.2.1 Materials of Classes 4.1, 4.2 and 4.3

9.3.2.1.1 Materials of these classes should be kept as cool and dry as reasonably practicable and stowed clear of all sources of heat or ignition.

9.3.2.1.2 Electrical fittings and cables should be in good condition and properly safeguarded against short circuits and sparking. Where a bulkhead is required for segregation purposes, cable and conduit penetrations of the decks and bulkheads should be sealed against the passage of gas and vapours.

9.3.2.1.3 Materials liable to give off vapours or gases that can form an explosive mixture with air should be stowed in a mechanically ventilated space.

9.3.2.1.4 Prohibition of smoking in dangerous areas should be enforced, and clearly legible "NO SMOKING" signs displayed.

9.3.2.2 Materials of Class 5.1

9.3.2.2.1 Materials of this class should be kept as cool and dry as reasonably practicable and stowed clear of all sources of heat or ignition. They should also be stowed "separated from" other combustible cargoes.

9.3.2.2.2 Before materials of this class are loaded, particular attention should be paid to the cleaning of the cargo spaces into which they will be loaded. As far as reasonably practicable, non-combustible securing and protecting materials and a minimum only of dry wooden dunnage should be used.

9.3.2.2.3 Precautions should be taken to avoid penetration of oxidizing materials into other cargo spaces, bilges, etc.

9.3.3 Segregation between bulk materials possessing chemical hazards and dangerous goods in packaged form.

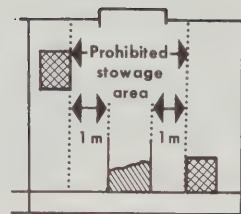
9.3.3.1 Unless this section or the individual entries in Appendix B require otherwise, segregation between bulk materials and dangerous goods in packaged form should be in accordance with the following table. For packaged dangerous goods, the individual schedules of the IMDG Code should be consulted for additional requirements with regard to stowage and segregation.

Bulk materials		Dangerous goods in packaged form																				
		1.1					2.2			3.1												
		1.5	1.2	1.3	1.4	2.1	2.3	3.2	3.3	4.1	4.2	4.3	5.1	5.2	6.1	6.2	7	8	9			
Flammable solids	4.1	4	4	3	2	2	2	2	2	X	2	2	2	2	X	3	2	1	X			
Substances liable to spontaneous combustion	4.2	4	4	3	2	2	2	2	2	2	X	2	2	2	X	3	2	1	X			
Substances which, in contact with water, emit flammable gases	4.3	4	4	4	2	1	X	2	2	2	2	X	2	2	X	2	2	1	X			
Oxidizing substances (agents)	5.1	4	4	4	2	2	X	2	2	2	2	2	X	2	2	3	2	2	X			
Poisonous (toxic) substances	6.1	2	2	2	X	X	X	X	X	X	X	X	1	1	X	1	X	X	X			
Radioactive materials	7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	X	2	2			
Corrosives	8	4	4	2	2	1	X	1	1	1	1	1	2	2	X	3	2	X	X			
Miscellaneous dangerous substances	9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Materials hazardous only in bulk (MHB)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	3	X	X	X			

Numbers related to the following segregation terms:

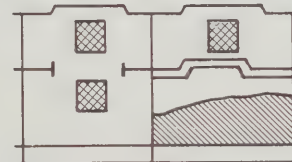
1 Away from:

Effectively segregated so that incompatible substances cannot interact dangerously in the event of an accident, but may be carried in the same hold or compartment or on deck provided a minimum horizontal separation of 3 metres projected vertically is provided.



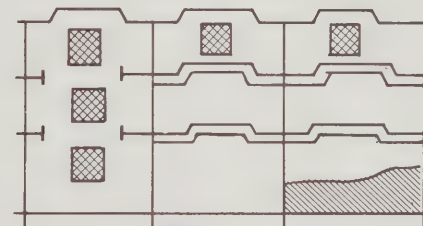
2 Separated from:

In different holds when stowed under deck. If an intervening deck is resistant to fire and liquid, a vertical separation, i.e. in different compartments, may be accepted as equivalent to this segregation.



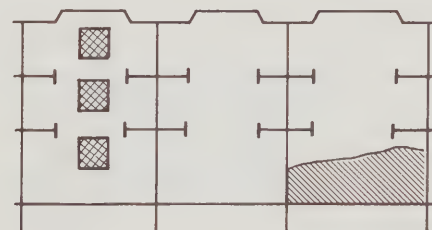
3 Separated from by a complete compartment or hold:

Means either a vertical or a horizontal separation. If the decks are not resistant to fire and liquid, then only a longitudinal separation is acceptable, i.e. by an intervening complete compartment.



4 Separated longitudinally from by an intervening complete compartment or hold:

Vertical separation alone does not meet this requirement.



X No general segregation required: individual entries in this Code and the individual schedules in the IMDG Code should be consulted.

Legend

Reference bulk cargo



Incompatible package



Deck resistant to liquid and fire



NOTE: Vertical lines represent transverse watertight bulkheads between cargo spaces.

9.3.4 Segregation between incompatible bulk materials possessing chemical hazards

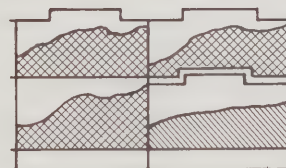
9.3.4.1 Unless this section or the individual entries in Appendix B require otherwise, segregation between incompatible bulk materials possessing chemical hazards should be according to the following table:

Solid Bulk Materials		Solid Bulk Materials								
		4.1	4.2	4.3	5.1	6.1	7	8	9	MHB
Flammable solids	4.1	X								
Substances liable to spontaneous combustion	4.2	2	X							
Substances which, in contact with water, emit flammable gases	4.3	3	3	X						
Oxidizing substances (agents)	5.1	3	3	3	X					
Poisons (toxic substances)	6.1	X	X	X	2	X				
Radioactive materials	7	2	2	2	2	2	X			
Corrosives	8	2	2	2	2	X	2	X		
Miscellaneous dangerous substances	9	X	X	X	X	X	2	X	X	
Materials hazardous only in bulk (MHB)		X	X	X	X	X	2	X	X	X

Numbers relate to the following segregation terms:

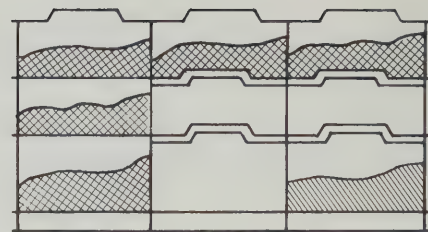
2 Separated from:

In different holds when stowed under deck. If an intervening deck is resistant to fire and liquid, a vertical separation, i.e. in different compartments, may be accepted as equivalent to this segregation.



3 Separated from by a complete compartment or hold:

Means either a vertical or a horizontal separation. If the decks are not resistant to fire and liquid, then only a longitudinal separation is acceptable, i.e. by an intervening complete compartment.



X No general segregation required: individual entries in this Code and the individual schedules in the IMDG Code should be consulted.

Legend

Reference bulk cargo



Incompatible bulk cargo



Deck resistant to liquid and fire



Note: Vertical lines represent transverse watertight bulkheads between cargo spaces.

SECTION 10 — STOWAGE FACTOR CONVERSION TABLES

10.1 Cubic metres per metric tonne to cubic feet per long ton (2240 lb, 1016 kg)

Factor: 1 m³/t 35.87 ft³/ton (rounded to the nearest hundredth of a ft³/ton)

m ³ /t	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
					ft ³ /ton					
0	—	0.36	0.72	1.08	1.43	1.79	2.15	2.51	2.87	3.23
0.10	3.59	3.95	4.30	4.66	5.02	5.38	5.74	6.10	6.46	6.82
0.20	7.17	7.53	7.89	8.25	8.61	8.97	9.33	9.68	10.04	10.40
0.30	10.76	11.12	11.48	11.84	12.20	12.55	12.91	13.27	13.63	13.99
0.40	14.35	14.71	15.07	15.42	15.78	16.14	16.50	16.86	17.22	17.58
0.50	17.94	18.29	18.65	19.01	19.37	19.73	20.09	20.45	20.80	21.16
0.60	21.52	21.88	22.24	22.60	22.96	23.32	23.67	24.03	24.39	24.75
0.70	25.11	25.47	25.83	26.19	26.54	26.90	27.26	27.62	27.98	28.34
0.80	28.70	29.05	29.41	29.77	30.13	30.49	30.85	31.21	31.57	31.92
0.90	32.28	32.64	33.00	33.36	33.72	34.08	34.44	34.79	35.15	35.51
1.00	35.87	36.23	36.59	36.95	37.31	37.66	38.02	38.38	38.74	39.10
1.10	39.46	39.82	40.17	40.53	40.89	41.25	41.61	41.97	42.33	42.69
1.20	43.04	43.40	43.76	44.12	44.48	44.84	45.20	45.56	45.91	46.27
1.30	46.63	46.99	47.35	47.71	48.07	48.43	48.78	49.14	49.50	49.86
1.40	50.22	50.58	50.94	51.29	51.65	52.01	52.37	52.73	53.09	53.45
1.50	53.81	54.16	54.52	54.88	55.24	55.60	55.96	56.32	56.67	57.03
1.60	57.39									

10.2 Cubic feet per ton (ft³/ton) (2240 lb, 1016 kg) to cubic metre tonne (m³/t) tonne (2204 lb, 1000 kg)

Factor: 1 ft³/ton 0.02788 m³/t (rounded to the nearest ten thousandth of a m³/t)

ft ³ /ton	0	1	2	3	4	5	6	7	8	9
					m ³ /t					
0	—	0.0279	0.0558	0.0836	0.1115	0.1394	0.1673	0.1952	0.2230	0.2509
10	0.2788	0.3067	0.3346	0.3624	0.3903	0.4182	0.4461	0.4740	0.5018	0.5297
20	0.5576	0.5855	0.6134	0.6412	0.6691	0.6970	0.7249	0.7528	0.7806	0.8085
30	0.8364	0.8643	0.8922	0.9200	0.9479	0.9758	1.0037	1.0316	1.0594	1.0873
40	1.1152	1.1431	1.1710	1.1988	1.2267	1.2546	1.2825	1.3104	1.3382	1.3661
50	1.3940	1.4219	1.4498	1.4776	1.5055	1.5334	1.5613	1.5892	1.6170	1.6449
60	1.6728	1.7007	1.7286	1.7564	1.7843	1.8122	1.8401	1.8680	1.8958	1.9237
70	1.9516	1.9795	2.0074	2.0352	2.0631	2.0910	2.1189	2.1468	2.1746	2.2025
80	2.2304	2.2583	2.2862	2.3140	2.3419	2.3698	2.3977	2.4256	2.4534	2.4818
90	2.5092	2.5371	2.5650	2.5928	2.6207	2.6486	2.6765	2.7044	2.7322	2.7601
100	2.7880									

APPENDIX A

List of bulk cargoes that may liquefy

A.1 General

A.1.1 This Appendix lists materials that may flow as a liquid and which, if shipped “wet”, may shift transversely during the voyage owing to the effects of moisture migration.

A.1.2 This list of materials is not exhaustive and the physical properties attributed to the materials are mentioned for guidance only. Consequently, whenever a shipment of a bulk cargo is contemplated, it is essential to obtain currently valid information about its physical properties before loading.

A.2 Mineral concentrates

A.2.1 Varying terminology exists to describe mineral concentrates. All known terms are stated but the list is not exhaustive.

A.2.2 The stowage factor of these materials is generally low — from 0.33 to 0.57 m³/tonne.

Blende (zinc sulphide)	Nefelin Syenite (mineral)
Chalco Pyrite	Nickel Ore Concentrate
Copper Nickel (concentrate or matte)	Pentahydrate Crude
Copper Ore Concentrate	Pyrite
Copper Precipitates	Pyrites (cupreous)
Galena (lead)	Pyrites (fine)
Ilmenite (“dry” & “moist”)	Pyrites (flotation)
Iron Ore Concentrate	Pyrites (sulphur)
Iron Ore (magnetite)	Pyritic Ashes (iron)
Iron Ore (pellet feed)	Pyritic Cinders
Iron Ore (sinter feed)	Silver Lead Ore Concentrate
Iron Pyrite	Slig (iron ore)
Lead and Zinc Calcines (mixed)	Zinc and Lead Calcines
Lead and Zinc Middlings	Zinc and Lead Middlings
Lead Ore Concentrate	Zinc Ore Concentrate
Lead Ore Residue	Zinc Ore (burnt ore particulate)
Lead Silver Ore (particulate)	Zinc Ore (calamine particulate)
Lead Sulphide	Zinc Ore (crude particulate)
Lead Sulphide (galena)	Zinc Sinter
Magnetite	Zinc Sludge
Magnetite-Taconite	Zinc Sulphide
Manganic Concentrate (manganese)	Zinc Sulphide (blende)

A.2.3 When these materials are loaded, reference should also be made to the entry “METAL SULPHIDE CONCENTRATES” in Appendix B.

A.3 Other materials

A.3.1 Many fine particle materials, if possessing a sufficiently high moisture content, are liable to moisture migration. Thus, any fine particle bulk cargo appearing excessively wet should be treated with caution and, if considered necessary, should be tested for flow characteristics before loading.

A.3.2 Fish in bulk can act as a cargo that may liquefy; for their containment, reference should be made to the *Large Fishing Vessel Inspection Regulations*.

A.3.3 The list below, which is not exhaustive, contains only materials (other than cargoes which may flow as a liquid) that have been reported as capable of attaining a flow state.

Material	Approximate Stowage Factor m ³ /tonne
Coal Slurry (watery silt, material normally under 1 mm in size)	0.98/1.15
Coal (fine particulate form) (fine particled)	0.79/1.53
Coke Breeze	1.8

APPENDIX B

List of bulk materials possessing chemical hazards

B.1 This Appendix lists materials known at the time of publication to be carried in bulk, and which possess a chemical hazard that could give rise to a dangerous situation on board ship.

B.2 This list of products is not exhaustive and the physical and chemical properties attributed to the materials are mentioned for guidance only. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain currently valid information about its physical and chemical properties before loading.

B.3 In circumstances where consultation with the competent authority is required before bulk shipment of materials, it is equally important to consult authorities at the ports of loading and discharge, concerning requirements that may be in force.

B.4 At the earliest opportunity, before completion of loading, the angle of repose of the material to be loaded should be determined (see Section 5) so as to ascertain which provisions of the Code relating to trimming apply (See Section 3).

B.5 Where required, the Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG) should be consulted before loading.

ALUMINIUM DROSS

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
NIL	MHB			

Properties

Contact with water may cause heating, with possible evolution of flammable and toxic gases such as hydrogen, ammonia and acetylene.

Special Requirements

Before loading, cargo should be as dry as possible and loading should not be permitted when the material is hot or during rain.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

Segregation as required for Class 4.3 materials.

To be "separated from" all Class 8 liquids.

To be kept as dry as reasonably practicable.

To be stowed in a mechanically ventilated space.

ALUMINIUM FERROSILICON, powder

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1395	4.3			

Properties

Contact with water may evolve hydrogen, a flammable gas that may form explosive mixtures with air. Impurities may, under similar circumstances, produce phosphine and arsine, which are highly toxic gases.

Observations

A certificate is required from the manufacturer or shipper stating that, after manufacture, the shipment was stored under cover, but exposed to the weather in the particle size in which it is to be shipped, for not less than three days before shipment.

Special Requirements

The cargo spaces should be ventilated by at least two individual fans. The total ventilation should be at least five air changes per hour based on empty space. Ventilation should be such that any escaping gases cannot reach living quarters or working areas on the deck. Bulkheads to the engine room should be gastight, inspected and approved by the competent authority.

At least two self-contained breathing apparatuses should be provided, additional to those required by Regulation 14 of Chapter II-2 of the SOLAS Convention.

At least two suitable detectors for quantitative measurements of phosphine and arsine should be on board. The measurements should be recorded and the information kept on board.

The powder must be protected from rain or snow during handling operations.

Segregation and Stowage Requirements

To be "separated from" foodstuffs and all Class 8 liquids.

To be kept as dry as reasonably practicable.

To be stowed in a mechanically ventilated space.

ALUMINIUM NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1438	5.1			

Properties

If involved in a fire will greatly intensify the burning of combustible materials and yield toxic nitrous fumes. Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely.

Observations

Fire-fighting requires flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Segregation and Stowage Requirements

To be "separated from" foodstuffs

ALUMINIUM SILICON, powder, uncoated

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1398	4.3			

Properties

Contact with water may evolve hydrogen, a flammable gas that may form explosive mixtures with air. Impurities may, under similar circumstances, produce phosphine and arsine, which are highly toxic gases. May also evolve silanes which are toxic and may ignite spontaneously.

Observations

A certificate is required from the manufacturer or shipper stating that, after manufacture, the shipment was stored under cover, but exposed to the weather in the particle size in which it is to be shipped, for not less than three days before shipment.

Special Requirements

The cargo spaces should be ventilated by at least two individual fans. The total ventilation should be at least five air changes per hour based on empty space. Ventilation should be such that any escaping gases cannot reach living quarters or working areas on the deck. Bulkheads to the engine room should be gastight, inspected and approved by the competent authority.

At least two self-contained breathing apparatuses should be provided, additional to those required by Regulation 14 of Chapter II-2 of the SOLAS Convention.

At least two suitable detectors for quantitative measurements of phosphine, arsine and silane should be on board. The measurements should be recorded and the information kept on board.

The powder must be protected from rain or snow during handling operations.

Segregation and Stowage Requirements

To be "separated from" foodstuffs and all Class 8 liquids.

To be kept as dry as reasonably practicable.

To be stowed in a mechanically ventilated space.

BARIUM NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1446	5.1			

Properties

The substance is toxic if swallowed or inhaled as dust. If involved in a fire, it will greatly intensify the burning of combustible materials and yield toxic nitrous fumes. Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely.

Observations

Fire-fighting requires flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Segregation and Stowage Requirements

To be "separated from" foodstuffs

CALCIUM NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1454	5.1			

Properties

If involved in a fire, it will greatly intensify the burning of combustible materials and yield toxic nitrous fumes. Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely.

Observations

The requirements of this Appendix do not apply to the commercial grade of calcium nitrate fertilizer, consisting mainly of a double salt (calcium nitrate and ammonium nitrate) and containing not more than 15.5% total nitrogen and at least 12% water (see Appendix C). Fire-fighting requires flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Special Requirements

Precautions should be taken to avoid penetration of the material into other cargo spaces, bilges, etc. which may contain combustible materials.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

CASTOR BEANS

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
2969	9			

Properties

Whole beans.

Castor beans contain a powerful allergen which, if inhaled as dust or by skin contact with crushed beans' products, can give rise to severe irritation of the skin, eyes and mucous membranes in some persons. They are also toxic if ingested.

Observations

Unnecessary skin contact should be avoided.

Penetration of dust into living quarters and working areas should be avoided.

Castor meal, Castor pomace and Castor flakes shall not be carried in bulk.

Special Requirements

Dust-mask and goggles should be worn when handling the material. A certificate from the shipper, stating that the product has undergone sufficient heat treatment to render it non-hazardous, should be available before shipment and presented to the master.

Segregation and Stowage Requirements

To be "separated from" foodstuffs and oxidizing materials.

CHARCOAL

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
NIL	MHB			

Properties

This substance may possibly ignite spontaneously. Contact with water may cause self heating.

Special Requirements

Transport of charcoal of Class 4.2 is not permitted in bulk. A certificate from the manufacturer or the shipper is required stating that the material as offered for shipment is not Class 4.2 based on the test carried out in accordance with Appendix D.4.

Charcoal screenings should be exposed to the weather for not less than five days before shipment. Hot charcoal in excess of 55°C after screenings should not be loaded. The moisture content of charcoal screenings should not be less than 15%.

Segregation and Stowage Requirements

Segregation as required for Class 4.1 materials.

To be "separated from" oily materials.

To be kept as dry as reasonably practicable.

COAL

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
NIL	MHB		30° to 65°	0.79 to 1.53

Properties

1. Coal may emit methane, a flammable gas. A methane/air mixture containing between 5% and 15% methane constitutes an explosive atmosphere, which can be ignited by sparks or naked flame, e.g. electrical or frictional sparks, a match or lighted cigarette. Methane gas is lighter than air and may, therefore, accumulate in the upper region of the cargo space and other spaces.
2. Some coals may be liable to spontaneous heating and could cause a cargo space fire. Flammable gases including carbon monoxide may be produced. Carbon monoxide has flammable limits in air of 12% to 75% by volume and is toxic by inhalation, with an affinity for blood haemoglobin more than 200 times that of oxygen.

Observations

For transport purposes coal may be placed in one of four categories:

- Category A:** Coal cargoes of a type that can be identified as having a history of shipment under similar circumstances without problems arising from methane emission or spontaneous heating.
- Category B:** Coal that has shown itself liable, or that may be liable, to emit methane in quantities sufficient to create a hazard.
- Category C:** Coal that has shown itself liable, or that may be liable, to spontaneous heating.
- Category D:** Coal that has shown itself liable, or that may be liable, to emit methane in quantities sufficient to create a hazard and be subject to spontaneous heating.

Special Requirements

1. Before loading, the shipper or the appointed agent should provide to the master the category of coal ready for loading. ★
2. The master should be satisfied that he has received such information before accepting the cargo. During loading and while the cargo remains on board, the master should observe the appropriate precautions as outlined here.

Category A Coal

- (1) All cargo spaces and bilge wells should be clean, dry and any residue of waste material from previous cargo removed, including removable cargo battens, before loading.
- (2) All electrical cables and components situated in cargo spaces and adjacent spaces should be free from defects and safe for use in a methane/dust atmosphere, or positively isolated.
- (3) Burning, cutting or other sources of ignition should not be allowed in the cargo spaces and adjacent spaces.
- (4) During loading the master should ensure that the cargo is not stowed adjacent to hot areas.
- (5) The surface of the cargo should be trimmed reasonably level.
- (6) Attention is drawn to the possibility of oxygen depletion in cargo spaces and reference should be made to Section 4, Safety of Personnel.

Category B Coal

- (1) All cargo spaces and bilge wells should be clean, dry and any residue of waste material from previous cargo removed, including removable cargo battens, before loading.
- (2) All electrical cables and components situated in cargo spaces and adjacent spaces should be free from defects and safe for use in a methane/dust atmosphere, or positively isolated.
- (3) Warning notices against smoking and the use of naked flames should be posted in the cargo area. No smoking, burning, cutting, chipping, or other sources of ignition should be allowed in the vicinity of cargo spaces and adjacent spaces.
- (4) During loading the master should ensure that the cargo is not stowed adjacent to hot areas.
- (5) Any gases that the cargo may emit should not be allowed to accumulate in adjacent enclosed spaces.
- (6) The surface of the cargo should be trimmed reasonably level to the boundary walls to avoid the formation of gas pockets and to prevent air from permeating the body of the coal. Casings leading into the cargo space should be adequately sealed.
- (7) Adequate surface ventilation should be provided but on no account should air be directed into the body of the coal, as air could promote spontaneous combustion.
- (8) Working spaces, e.g. store-rooms, carpenter's shop, etc. should be regularly monitored for the presence of methane. ★★ Such spaces should be adequately ventilated and, in the case of mechanical ventilation, only equipment safe for use in a methane/dust atmosphere should be used.
- (9) Personnel should not be allowed to enter a space where methane may accumulate unless they are wearing self-contained breathing apparatus, or the space has been tested and found to have sufficient oxygen to support life and to be gas-free. Only personnel trained in its use should wear self-contained breathing apparatus (see also Section 4).
- (10) Where for any reason it has not been possible to ventilate cargo spaces, before removal of hatches or other openings and unloading, care should be taken to vent any accumulated gases.

Category C Coal

- (1) If heating of the coal to be loaded is suspected, expert advice should be sought before loading.
- (2) All cargo spaces and bilge wells should be clean, dry and any residue or waste material from previous cargoes removed, including removable cargo battens, before loading.
- (3) All electrical cables and components situated in cargo and adjacent spaces should be free from defects and safe for use in a methane/dust atmosphere, or positively isolated.
- (4) Warning notices against smoking and the use of naked flames should be posted in the cargo space area. No smoking, burning, cutting, chipping or other sources of ignition should be allowed in the vicinity of cargo spaces or adjacent spaces.
- (5) During loading the master should ensure that the cargo is not stowed adjacent to hot areas.
- (6) The surface of the cargo should be trimmed reasonably level to the boundary walls so that air is not permitted to permeate the body of the coal. Casings leading into the cargo spaces should be adequately sealed.
- (7) Surface ventilation should be limited to the extent necessary to remove gases that may have accumulated. Forced ventilation should not be used. Should the cargo temperature be rising rapidly, ventilation should be shut down.
- (8) On long sea voyages and when required by the competent authority, suitable means should be provided to enable temperature to be taken at least once daily at three evenly situated locations, approximately 3 metres below the surface in each cargo space. Temperature readings should be taken without requiring entry to the cargo space.
- (9) Personnel should not be allowed to enter a cargo space where carbon monoxide may develop due to spontaneous heating of the coal, unless they are wearing self-contained breathing apparatus, or the space has been tested before entry and found to have sufficient oxygen to support life and to be gas-free. Only personnel trained in its use should wear self-contained breathing apparatus (see also Section 4).

(10) If the cargo temperature exceeds 55°C and is increasing rapidly, a potential fire situation may be developing. The cargo spaces should be completely closed down and all ventilation terminated. The master should seek expert advice immediately and consider making for the nearest suitable port of refuge. Water should **not** be used for cooling the cargo or fire-fighting at sea, but may be used for cooling the boundaries.

Category D Coal

(1) Where a cargo is suspected of being potentially hazardous due to both methane emission and spontaneous heating, methane should be considered to be the more immediate hazard and recommendations pertaining to it (i.e. Category B) should be followed. Temperature monitoring, however, is recommended for the entire voyage as described for Category C, paragraph 8.

(2) If the cargo temperature exceeds 55°C and is increasing rapidly, the master should seek expert advice immediately and consider making for the nearest suitable port of refuge. Water should not be used for cooling the cargo or fire-fighting at sea, but may be used for cooling the boundaries.

★Details of the method of categorization should be provided to the master on request.

★ ★A methanometer, a gas detector or an explosimeter suitably calibrated for use in a methane atmosphere can be used for monitoring. For such an instrument to give reliable results, it should be regularly serviced and calibrated, and while on board properly maintained.

COPRA, dry

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1363	4.2			

Properties

This substance consists of dried kernels of coconuts with a penetrating rancid odour, which may taint other cargoes. It is liable to heat and ignite spontaneously.

Observations

Shipment should be refused when wet.

Segregation and Stowage Requirements

Good surface ventilation to be provided.

DIRECT REDUCED IRON (DRI) lumps, pellets and cold molded briquettes

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor· m ³ /t
Nil	MHB		33° Briquettes may be less	0.5

Definition

Direct Reduced Iron (DRI), a metallic product of a manufacturing process, is formed by the reduction (removal of oxygen) of iron oxide at temperatures below the fusion point of iron. The average particle size of lumps and pellets is 6 mm to 25 mm with up to 5% fines (less than 4 mm). Cold molded briquettes are defined as those that have been molded at a temperature of less than 650°C, or which have a density of less than 5.0g/cm³. Their approximate maximum diameter is 35 to 40 mm.

Properties

DRI may react with water and air to produce hydrogen and heat. The heat produced may cause ignition. Oxygen in an enclosed space may be depleted.

Special Requirements

1. A competent person, recognized by the competent authority of the country of shipment, should certify to the ship's Master that the DRI, at the time of loading, is suitable for shipment.
2. Shippers should certify that the material conforms with the requirement of this Code.
3. This material is not to be loaded if its temperature exceeds 65°C.
4. This material is to be loaded dry and loading shall not be conducted during rain or snow.
5. The ship shall be fitted with means of introducing inert gas into the cargo spaces on completion of loading and be capable of maintaining an inert atmosphere containing less than 5% oxygen by volume during the voyage. The hydrogen content of the atmosphere should be maintained at less than 1% by volume.
6. The ship shall be equipped with systems for continuous monitoring of the oxygen and hydrogen concentrations in every cargo space in which this material is carried. The detectors shall be suitable for use in an inert atmosphere.
7. The ship shall be provided with portable meters for measuring oxygen and hydrogen concentrations.
8. Smoking and the use of naked lights or spark-producing equipment shall be prohibited in the vicinity of cargo space containing this material.
9. Hatch covers and other openings to the cargo spaces are to be closed and sealed during the voyage.
10. The shipper must provide the master of the ship with operational guidelines.
11. Any shipment that is wet, or is known to have been wetted, should not be accepted for carriage. Materials should be loaded, stowed and transported under dry conditions.
12. Monitoring for the presence of oxygen and hydrogen shall be carried out at regular intervals throughout the voyage, recorded, and the readings reported to the shipper.
13. Holds containing DRI products may become oxygen depleted and all due caution must be exercised upon entering such compartments.

14. Radar and RDF scanners should be adequately protected against dust during loading and discharging operations.

Segregation and Stowage Requirements

To be "separated from" materials of Classes 2, 3, 4 and 5 and Class 8 acids.

DIRECT REDUCED IRON (DRI), hot molded briquettes

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		38°	0.35

Definition

This is a product of a densification process whereby the DRI feed material is at a temperature greater than 650°C at time of molding and has a density greater than 5.0g/cm³.

Properties

The product may slowly evolve hydrogen after contact with water.

Temporary self heating of about 30°C may be expected after material handling in bulk.

Approx. size length 90 to 130 mm

width 80 to 100 mm

thickness 20 to 50 mm

Briquette wt. 0.5 to 2.0 kg

Fines: up to 5% (less than 4 mm)

Observations

Open storage is acceptable before loading.

Loading during rain is unacceptable. Unloading under any weather condition is acceptable.

During discharge a fine spray of fresh water is permitted for dust control.

Special Requirements

1. A competent person, recognized by the competent authority of the country of shipment, should certify to the ship's Master that the DRI, at the time of loading, is suitable for shipment.
2. Shippers should certify that the material conforms with the requirement of this Code.
3. Hot molded briquettes should not be loaded if product temperature exceeds 65°C (150°F).
4. Holds containing DRI products may become oxygen depleted and all due caution must be exercised upon entering such compartments.
5. Adequate surface ventilation should be provided.
6. Radar and RDF scanners should be adequately protected against dust during loading and discharging operations.

Segregation and Stowage Requirements

To be "separated from" materials of Classes 2, 3, 4 and 5 and Class 8 acids.

FERROPHOSPHORUS

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB			

Properties

Contact with water may evolve flammable and toxic gases (e.g. phosphine.)

Observations

The requirements of this Appendix do not apply to ferrophosphorus briquettes.

Segregation and Stowage Requirements

Segregation as required for Class 4.3 materials.

To be "separated from" foodstuffs and all Class 8 liquids.

To be kept as dry as reasonably practicable.

To be stowed in a mechanically ventilated space.

FERROSILICON, containing more than 30% but less than 90% silicon

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1408	4.3		45°	0.48 to 0.72

Properties

Contact with moisture or water may evolve hydrogen, a flammable gas that may form explosive mixtures with air. Impurities may, under similar circumstances, produce phosphine and arsine, which are highly toxic gases. These gases are evolved in proportions which, under mechanically ventilated conditions, make the poison hazard far predominant to the explosion hazard. The rate of gas evolution is greatest from freshly broken surfaces, so it is liable to increase whenever the cargo is distributed, e.g. during loading.

Observations

The requirements of this Appendix do not apply to ferrosilicon briquettes that are a mixture of ferrosilicon with water and a binder such as cement moulded into briquettes. Before loading, a certificate is required from the manufacturer or shipper stating that, after manufacture, the shipment was stored under cover, but exposed to the weather in the particle size in which it is to be shipped, for not less than three days before shipment.

Special Requirements

The cargo spaces should be ventilated by at least two individual fans. The total ventilation should be at least five air changes per hour based on the empty space. Ventilation should be such that any escaping gases cannot reach living quarters or working areas on the deck.

Bulkheads to the engine room should be gastight, inspected and approved by the competent authority, who should also be satisfied as to the safety of the bilge pumping arrangements. Inadvertent pumping through machinery spaces should be avoided.

At least two self-contained breathing apparatuses should be provided, additional to those required by Regulation 14 of Chapter II-2 of the SOLAS Convention.

At least two suitable detectors for quantitative measurements of phosphine and arsine should be on board. The measurements should be recorded and the information kept on board.

The material must be protected from rain or snow during handling operations.

Segregation and Stowage Requirements

To be "separated from" foodstuffs and all Class 8 liquids.

To be kept as dry as reasonably practicable.

To be stowed in a mechanically ventilated space.

**FERROUS METAL, borings, shavings, turnings, cuttings
IRON SWARF, STEEL SWARF**

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
2793	4.2			

Properties

These materials are liable to self heat and to ignite spontaneously, particularly when in a finely divided form, wet or contaminated with such materials as unsaturated cutting oil, oily rags and other combustible matter. Self-heating or inadequate ventilation may cause dangerous depletion of oxygen in the cargo spaces.

Observations

Excessive amounts of cast iron borings or organic materials may encourage heating. The material should be protected from moisture before and after loading. If, during loading, the weather is inclement, hatches should be closed or otherwise protected to keep the material dry.

The requirements of this Appendix do not apply when the consignment is accompanied by a declaration, submitted before loading by the shipper, stating that it has no self-heating properties when transported in bulk.

Special Requirements

1. Before loading, temperature of the material should not exceed 55°C. Wooden seat battens, dunnage and debris should be removed from the cargo space before the material is loaded.
2. The surface temperature of the material should be taken before, during and after loading and daily during the voyage. If the surface temperature exceeds 90°C during loading, further loading should cease and not recommence until the temperature has fallen below 85°C.

The ship should not sail unless the temperature is below 65°C and has shown a steady or downward trend in temperature for at least eight hours. During loading and transport the bilge of each cargo space in which the material is stowed should be as dry as practicable. During loading the material should be compacted in the cargo space as frequently as practicable with a bulldozer or by other means. After loading, the material should be trimmed to eliminate peaks and compacted.

3. While at sea any rise in surface temperature of the material indicates a self-heating reaction problem. If the temperature should rise to 80°C, a potential fire situation is developing and the ship should make for the nearest port.

Water should not be used on the cargo at sea. Early application of an inert gas to a smouldering situation may be effective. In port, copious quantities of water may be used but due consideration must be given to stability.

4. Entry into cargo spaces containing this material should be made only with the main hatches open and after adequate ventilation and when using breathing apparatus.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

FISHMEAL, FISHSCRAP, anti-oxidant treated, moisture content between 5% and 11% by weight, fat content not more than 18% by weight.

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
2216	9			

Properties

This is a brown to greenish-brown product obtained through heating and drying of fish. It has a strong odour which may affect other cargo. It is liable to heat spontaneously unless the fat content is low or it has been effectively anti-oxidant treated.

Observations

1. Stabilization of fishmeal should be achieved to prevent spontaneous combustion by effective application of between 400 and 1000 mg/kg (ppm) Ethoxyquin, or between 1000 or 4000 mg/kg (ppm) Butylated hydroxytoluene at the time of production.

This application should take place not more than twelve months before shipment. Anti-oxidant remnant concentration should be not less than 100 mg/kg (ppm) at the time of shipment.

2. Certificates from an authority recognized by the competent authority of the country of shipment should state: moisture content, fat content, details of anti-oxidant treatment for meals older than six months, anti-oxidant concentration at the time of shipment (must exceed 100 mg/kg (ppm)), total weight of the consignment, temperature of fishmeal at the time of dispatch from the factory and the date of production.

3. The requirements of this Appendix do not apply to consignments of fishmeal accompanied by a certificate issued by the competent authority of the country of shipment, stating that the product does not have self-heating properties when transported in bulk.

Note: No weathering/curing is required before loading.

Special Requirements

1. The temperature of the cargo should not, at the time of loading, exceed 35°C or 5°C above ambient temperature, whichever is higher.

2. Temperature readings should be taken at eight-hour intervals throughout the cargo. The readings should be recorded and the information kept on board.

3. If the temperature of the cargo exceeds 55°C and continues to increase, ventilation to the cargo space should be restricted. If self-heating continues, then carbon dioxide or inert gas should be introduced.

Segregation and Stowage Requirements

Segregation as required for Class 4.2 materials.

FLUORSPAR, (Calcium fluoride)

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
NIL	MHB		Dry 28° to 35° Wet 50° to 60°	Dry 0.56to0.70 Wet 0.47to0.56

Properties

This product is harmful and irritating if inhaled as dust.

Observations

This product is shipped as a coarse dust.

Special Requirements

Exposure of persons to dust should be minimized.

Segregation and Stowage Requirements

To be "separated from" foodstuffs and all Class 8 materials.

IRON OXIDE, spent
IRON SPONGE, spent

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1376	4.2		30° to 35°	0.45

Properties

This product, obtained from coal gas purification, is liable to heat and ignite spontaneously, especially if contaminated with oil or moisture. It may evolve hydrogen sulphide, sulphur dioxide and hydrogen cyanide which are toxic gases. Fine dust particles suspended in air present a dust explosion risk.

It has a strong odour that may taint other cargo.

Special Requirements

It should be cooled and then weathered for not less than eight weeks, and so certified by the shipper before loading.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

LEAD NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1469	5.1			

Properties

Although this product is not combustible itself, mixtures of it with combustible materials are easily ignited and may burn fiercely. It is toxic if swallowed or inhaled as dust.

Observations

Fire-fighting requires flooding amounts of water. In early stages of fire, the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Special Requirements

Exposure of persons to dust should be minimized.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

LIME, unslaked (Calcium Oxide)
Quick Lime

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB			

Properties

Unslaked lime combines with water to form calcium hydroxide or hydrated lime. This reaction develops a great deal of heat which may be sufficient to cause ignition in contact with nearby combustible materials.

Observations

This product is corrosive to eyes and mucuous membranes.

Special Requirements

Exposure of persons to dust should be minimized.
Persons handling the material should use dust mask and goggles.

Segregation and Stowage Requirements

To be "separated from" all other cargo.
To be kept dry.

MAGNESIUM NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1474	5.1			

Properties

Although this product is non-combustible itself, mixtures of it with combustible materials are easily ignited and may burn fiercely.

Observations

Fire-fighting requires flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials.

Self-contained breathing apparatus should be worn.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

METAL SULPHIDE CONCENTRATES

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		30° to 60°	0.31 to 0.56

Properties

These are solid, finely divided sulphide concentrates of copper, iron, lead, nickel, zinc or other metalliferous ores.

Some sulphide concentrates are liable to oxidation and may have a tendency to self heat with associated oxygen depletion and emission of toxic fumes.

Some concentrates may present corrosion problems.

Observations

Before shipment the shipper or the competent authority should provide detailed information concerning any specific hazards and the precautions to be followed, based on the history of carriage of the concentrates to be loaded.

Special Requirements

If the concentrates are dry and dusty, loading and unloading operations should be closely supervised to minimize exposure to dust.

Depending upon the advice of the shipper or the competent authority, these precautions should be followed:

- (1) Oxygen stimulates the process of oxidation and self-heating, and thus ventilation of the concentrates should be avoided. Compacting the cargo or restricting the ingress of air by carefully covering the concentrate with plastic sheeting may also inhibit oxidation.
- (2) To decrease the effects of oxidation, concentrates should be reasonably levelled after loading.
- (3) Entry by personnel into cargo spaces containing concentrates should not be permitted until the master of the ship or the responsible officer is satisfied that it is safe to do so, after taking into account all safety precautions.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

To be "separated from" all Class 8 acids.

When determined necessary by the competent authority, segregation as required for Class 4.2 materials.

PETROLEUM COKE calcined

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		33° to 42°	1.25 to 1.67

Properties

This material may be transported hot.

Observations

The requirements of this Appendix do not apply to this material when it has a temperature below 55°C when loaded.

Special Requirements

1. This material should not be loaded when the temperature exceeds 107°C.
2. In cargo spaces over tanks containing fuel or material having a flashpoint under 93°C, a layer of 0.6 — 1.0 m of the material at a temperature not greater than 44°C should first be loaded into the cargo space. Only then may the material, at 55°C or above, be loaded into that cargo space.
3. The loading of the material should be as follows:
 - 1. For shipments in cargo spaces over fuel tanks, loading of the 0.6 — 1.0 m. layer of the material at a temperature not greater than 44°C (as required by 2) should be completed before loading of the material at 55°C or above in any cargo space of the ship.
 - 2. Upon completion of the loading described in 3.1, a layer of 0.6 — 1.0 m of the material at 55°C or above should first be loaded in each cargo space (including those cargo spaces, if any, already containing a layer of the material at a temperature not greater than 44°C) in which the material is to be loaded in accordance with this entry.
 - 3. Upon completion of the loading of the 0.6 — 1.0 m layer of the material at 55°C or above in each cargo space (as required in 3.2), the normal loading of the material at 55°C or above may proceed to completion.
 - 4. The master of the ship should warn personnel that calcined petroleum coke loaded and transported under this entry is hot and that burn injuries are possible if precautions are not taken.

Segregation and Stowage Requirements

To be “separated from” foodstuffs.

To be “separated longitudinally by an intervening complete compartment or hold from” all substances and articles in Class 1, Division 1.1 and 1.5.

To be “separated by a complete compartment or hold from” all other dangerous goods and MHBs.

PETROLEUM COKE uncalcined

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		33° to 42°	1.25 to 1.67

Properties

This black, finely divided residue from petroleum refining in the form of powder and small pieces is liable to heat and ignite spontaneously.

Special Requirements

This material should not be accepted for transport if its temperature exceeds 55°C. Wooden sweat battens and dunnage should be removed, and cargo spaces cleaned before loading. If the temperature exceeds 44°C the shipment should be monitored and recorded during the voyage.

Segregation and Stowage Requirements

Segregation as required for Class 4.2 materials.

PITCH PRILL, PRILLED COAL TAR, PENCIL PITCH

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		22° to 38°	1.25 to 1.67

Properties

This substance exists in various sizes, melts when heated, is combustible and burns with a dense black smoke. It is hazardous because of its flammability. Dust may cause skin and eye irritation.

Observations

In extremely warm weather loading or unloading may not be possible owing to dust irritation.

Special Requirements

Precautions should be taken to avoid either skin or eye exposure. Decks should be washed down frequently to remove dust deposits. Loading and unloading operations should be closely supervised to prevent exposure to dust.

Segregation and Stowage Requirements

Segregation as required for Class 4.1 materials.

POTASSIUM NITRATE (saltpetre)

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1486	5.1		30° to 31°	0.88

Properties

Although this product is non-combustible, mixtures of it with combustible materials are readily ignited and may burn fiercely.

Observations

Fire-fighting requires flooding amounts of water. In early stages of fire, the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

SAWDUST

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB			

Properties

Sawdust is liable to cause oxygen depletion within the cargo space.

If not shipped clean, dry, and free from oil, it is liable to spontaneous combustion.

Observations

It should only be shipped when clean, dry and free from oil.

Segregation and Stowage Requirements

Segregation as required for Class 4.1 materials.

To be "separated from" all Class 8 liquids.

To be kept dry.

SEED CAKE, containing vegetable oil, solvent extracted and containing not more than 10% oil and, when the amount of moisture is higher than 10%, not more than 20% oil and moisture combined.

“MEAL OILY, OIL CAKE, SEED EXPELLERS OILY”

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1386	4.2		Varies greatly from 25° to 45°	1.39 to 2.09

Properties

This substance is the residue remaining after oil has been extracted from oil-bearing seeds by a solvent process. It is used mainly as animal feed or fertilizer. The most common seed cakes include those derived from coconut (copra), cotton-seed, groundnut (peanut), linseed, maize (hominy chop), niger seed, palm kernel, rape seed, rice bran, soya bean and sunflower seed; they may be shipped in the form of cake, flakes, pellets, meal, etc.

Seed cakes may self heat slowly, and ignite spontaneously, if wet or containing an excessive proportion of unoxidized oil. It is liable to oxidation causing subsequent reduction of oxygen in the cargo space. Carbon dioxide may also be produced.

Observations

Before shipment this cargo should be properly aged; the duration of aging required varies with the oil content.

The requirements of this Appendix do not apply to solvent-extracted rape seed meal, soya bean meal and linseed meal (including their pelletized forms) containing not more than 4% oil, 15% oil and moisture combined and being substantially free from inflammable solvent. A certificate from an authority recognized by the competent authority of the country of shipment should be provided by the shipper, stating that the requirements for the exemption are met.

Special Requirements

1. A certificate from a recognized authority should state the oil and moisture contents.
2. If solvent-extracted, the seed cake should be substantially free from flammable solvent.
3. Surface ventilation will promote the removal of any residual solvent vapour.
4. The seed cake should be kept dry.
5. If the voyage exceeds five days, the ship should be equipped with facilities for introducing carbon dioxide or inert gas into the cargo spaces.
6. Regular temperature readings should be taken at varying depths in the cargo spaces and recorded. If the temperature of the cargo exceeds 55°C and continues to increase, ventilation to the cargo space should be restricted. If self-heating continues, then carbon dioxide or inert gas should be introduced. In the case of solvent-extracted seed cakes, carbon dioxide should be withheld until fire is apparent to avoid the possibility of ignition of solvent vapours by the generation of static electricity.
7. Smoking and the use of naked lights should be prohibited during loading and unloading as well as on entry to the cargo spaces at any other time.
8. Electrical fuses in cargo space should be extracted. Spark-arresting screens should be fitted to ventilators.

Segregation and Stowage Requirements

To be stowed in a mechanically ventilated cargo space.

SILICOMANGANESE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		42° to 45°	0.18 to 0.26

Properties

In contact with water, alkalis or acids, this substance may evolve hydrogen, a flammable gas, and may also produce phosphine and arsine, which are highly toxic gases.

Observations

A certificate is required from the manufacturer or shipper stating that, after manufacture, the shipment was stored under cover, but exposed to the weather, for not less than three days before shipment. The requirements of this Appendix do not apply to silicomanganese briquettes.

Special Requirements

Ventilation should be such that any escaping gases cannot reach living quarters or working areas.

Segregation and Stowage Requirements

Segregation as required for Class 4.3 materials.

To be "separated from" foodstuffs and all Class 8 liquids.

To be stowed in a mechanically ventilated space.

To be kept dry.

SODIUM NITRATE (CHILE SALTPETRE) CHILEAN NATURAL NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1498	5.1		30° to 31°	0.88

Properties

Sodium nitrate is a deliquescent substance.

Although non-combustible, mixtures with combustible material are readily ignited and may burn fiercely.

Observations

Fire-fighting requires flooding amounts of water.

In early stages of fire, the nitrate may fuse or melt, in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

SODIUM NITRATE and POTASSIUM NITRATE, mixture
CHILEAN NATURAL POTASSIC NITRATE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1499	5.1		30°	0.88

Properties

This mixture is prepared as a fertilizer, and is hygroscopic. Although non-combustible, mixtures with combustible material are readily ignited and may burn fiercely.

Observations

Fire-fighting requires flooding amounts of water. In early stages of fire, the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Self-contained breathing apparatus should be worn.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

SULPHUR (lump or coarse-grained powder)

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1350	4.1		35° to 40°	0.74

Properties

Sulphur ignites readily. When involved in a fire, it evolves toxic, irritating and suffocating gas. It forms explosive and sensitive mixtures with most oxidizing materials. Bulk sulphur has a liability to dust explosion, which may occur especially after discharge and during cleaning.

Observations

Fine-grained sulphur (flowers of sulphur) should **NOT** be transported in bulk. Risk of explosions may be minimized by preventing the atmosphere becoming dust laden through adequate (preferably mechanical) ventilation or hosing down, preferably with fresh water, instead of sweeping. Residues are highly corrosive to steel, in particular in the presence of moisture.

Special Requirements

Protect from sparks and open flame. Electrical fuses in cargo spaces should be extracted. Spark arresting screens should be fitted to ventilators.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

TANKAGE Garbage tankage containing 8% or more moisture.
Rough Ammonia tankage containing 7% or more moisture.
Tankage Fertilizer containing 8% or more moisture.

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB			

Properties

Tankage is subject to spontaneous heating and possible ignition; it is possibly infectious.

Special Requirements

Tankage should not be loaded if the temperature is above 38°C. Temperatures should be observed during the voyage for a possible heating trend.

Segregation and Stowage Requirements

To be "separated by a complete cargo space or hold from foodstuffs."
Segregation as required for Class 4.2 materials.

VANADIUM ORE

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB			

Properties

Dust may contain toxic constituents

Special Requirements

Exposure of persons to dust should be minimized.

Segregation and Stowage Requirements

To be "separated from" foodstuffs.

Segregation as required for Class 6.1 materials.

WOODCHIPS

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
Nil	MHB		45°	3.07

Properties

Some consignments of woodchips may be subject to oxidation, leading to depletion of oxygen and an increase of carbon dioxide in the cargo space.

Special Requirements

Entry by personnel into cargo spaces containing this material should not be permitted until the master of the ship or the responsible officer is satisfied that it is safe to do so, after taking into account all safety precautions.

Segregation and Stowage Requirements

Segregation as required for Class 4.1 materials.

WOOD PULP PELLETS

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
NII	MHB		45°	3.07

Properties

Some consignments of wood pulp pellets may be subject to oxidation, leading to depletion of oxygen and an increase of carbon dioxide in the cargo space.

Special Requirements

Entry by personnel into cargo spaces containing this material should not be permitted until the master of the ship or the responsible officer is satisfied that it is safe to do so, after taking into account all safety precautions.

Segregation and Stowage Requirements

Segregation as required for Class 4.1 materials.

ZINC ASHES, DROSS, RESIDUES, SKIMMINGS

U.N. No	IMO Class	Other Requirements	Approximate Angle of Response	Approximate Stowage Factor m ³ /t
1435	4.3			

Properties

In contact with moisture or water, these substances are liable to give off hydrogen, a flammable gas, and toxic gases.

Special Requirements

1. Any shipment of this material requires approval of the competent authorities of the countries of shipment and the flag state of the ship.
2. Any shipment that is wet or is known to have been wetted should not be accepted for carriage. Material should be handled and transported under dry conditions.
3. Ventilation must be adequate to prevent hydrogen buildup.
4. All sources of ignition must be eliminated as far as practicable. This includes hot work, burning, cutting, smoking, electrical sparking, etc. during handling and transport.

Segregation and Stowage Requirements

"To be separated from" foodstuffs and all Class 8 liquids.

APPENDIX C

List of bulk cargoes that are neither liable to liquefy (Appendix A) nor possess chemical hazards (Appendix B)

C-1 This list of materials is not exhaustive and the physical and chemical properties attributed to the materials are mentioned for guidance only. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain from the shipper currently valid information about its physical and chemical properties before loading.

C-2 At the earliest opportunity, before completion of loading, the angle of repose of the material to be loaded should be established (see Section 5) so as to ascertain which provisions of the Code relating to trimming apply (see Section 3).

C-3 Some materials listed in this Appendix will also be found in Appendix A, owing to the difference in particle size, which may contribute to liquefaction.

Material	Approximate angle of repose	Approximate stowage factor m ³ /t	Properties, observations and special requirements
Alumina	15° to 40°	0.92 to 1.28	Fine white crystalline powder. Insoluble in water and organic liquids. Used in preparation of paint, dying calico print. Moisture: 0 to 5%; abrasive.
Alumina Calcined (calcined clay)	38° to 40°	0.61	Consists of lumps, particles and pieces with small amount of powder, dusty. Moisture: none. Light to dark grey.
Alumina Silica	35°	0.70	Consists of alumina and silica crystals - 60% lumps, 40% coarse grain powder. Moisture: 1 to 5%; white.
Alumina Silica pellets	35°	0.78 to 0.84	Length 6.4 to 25.4 mm. Diameter: 6.4 mm. Moisture: none; Off white.
Ammonium Sulphate	28° to 35°	0.95 to 1.06	Chemical fertilizers. A crystalline solid, which readily absorbs moisture. Moisture: 0.04 to 0.5%. Liable to cake as a result of absorption of moisture. Carried in bulk. Danger of heavy corrosion of framing, side plating etc. is present if sweating of holds develops. Ammonia odour. Subject to natural loss in weight.
Barytes	37°	0.34	Crystalline ore mineral. A sulphate of barium. Used in paints, textiles and as fillers for paper. 80% lumps — 6.4 to 101.6 mm. 20% fines — 6.4 mm. Moisture: 1 to 6%.
Bauxite	28° to 55°	0.72 to 0.84	Clay-like and earthy ore. The principal ore of aluminium. 70 to 90% lumps — 2.5 to 500 mm. 10 to 30% powder. Moisture: 0 to 10%, Brownish yellow.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Borax Anhydrous (crude or refined)	35°	0.78	Uniform granular material; will pass through 12 mesh screen. Highly refined, is of white crystalline appearance. The crude material is normally of yellow white appearance; can be dusty; dust is irritating but not toxic, if inhaled. Hygroscopic and will cake if wet; very abrasive.
Carborundum	40°	0.56	A hard crystalline compound of carbon and silicon. Slight toxicity by inhalation. Used as an abrasive and for refractory purposes. 75% lumps: 203.2 mm. 25% lumps: 12.7 mm. Moisture: none. Odourless. Black.
Cement	8° to 90°	0.67 to 1.00	Fine grey powder. Maximum particle size 0.1 mm. Both specific gravity and angle of repose are dependent upon the amount of air in the cargo. Cement contracts approximately 12% from an aerated to a non-aerated state. Normally cement is carried in specially designed ships and trimming is carried out with special equipment. Masters of vessels not specially fitted for the carriage of cement should consult the Canadian Coast Guard, Ship Safety Branch, for advice. Cargo should be trimmed reasonably level and consideration given to either remaining alongside for 12 hours to allow the escape of entrapped air or the fitting of shifting board/feeder arrangements. After the cargo has settled shifting should not normally occur unless the angle of repose exceeds 30°. Should be kept dry before loading; bilges should be made sift proof and compartments thoroughly cleaned. Contamination of cement renders it useless as a binding agent.
Cement Clinkers	24° to 45°	0.61 to 0.84	Unground cement. Size: 0 to 40 mm. Moisture: 0 to 5%.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Chamotte	32°	1.50	Burned clay. Shipped in the form of fine crush stone. Used by zinc smelters and in manufacture of firebrick (road metal). Size: Up to 10 mm. Grey.
Chrome Ore	33° to 40°	0.33 to 0.45	Ore. Size: 6.4 to 254 mm. Hard, compact, granular, crystalline. Bluish black.
Chrome Pellets	23°	0.60	Pellets. Size: 10 to 25 mm. Moisture: up to 2% maximum.
Clay	30° to 55°	0.66 to 1.34	Powdery to 100 mm. Moisture: up to 18%. Odourless. Whitish to beige.
Coke (coal origin)	33° to 45°	1.25 to 2.93	Used for furnace work and as a fuel. From fines up to 120 mm. Moisture: 5 to 20%.
Colemanite	47°	0.61	A natural hydrated calcium borate. Used in boric acid and sodium borate. Fine to large lumps: 300 mm. Moisture: approximately 7%. Light grey appearance similar to clay.
Copper Granules	25° to 30°	0.22 to 0.25	Sphere-shaped pebbles; fuses up to 10 mm with clinkers up to 50 mm. 75% copper with lead, tin, zinc, traces of others. Moisture: 1.5% approximately. Odourless. Dry: light grey. Wet: dark green.
Copper Matte	45°	0.25 to 0.35	Crude black copper ore. Small metallic round stones or pellets. Size: 3 to 25 mm. 75% copper; 25% impurities. Moisture: none. Odourless. Metallic black.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Cryolite	45°	0.70	A fluoride of sodium and aluminium used in production of aluminium and for ceramic glazes. Pellets: 6.4 to 12.7 mm long. Slightly pungent odour. Grey. Prolonged contact may cause serious damage to the skin and nervous system.
Diammonium Phosphate	30°	1.20	Fertilizer. Diameter: 2.54 mm. Grey. Slightly pungent odour.
Dolomite	36° to 42°	0.56 to 0.65	A carbonate of calcium and magnesium. Used for refractory purposes, road construction and as a fertilizer compound. Size: 0.1 to 19.00 mm. Moisture: none. Odourless. Off white, brown tones.
Feldspar Lump	35° to 45°	0.60	Crystalline minerals consisting of silicates of aluminium with potassium, sodium, calcium and barium. Used in ceramics and enamelling. Shipment in different sizes between 0.1 and 300 mm. White or reddish colour.
Ferrochrome	45°	0.18 to 0.26	Raw material of iron mixed with chrome. Shipment in different sizes between 0 and 300 mm. Moisture: none.
Ferrochrome exothermic	45°	0.18 to 0.26	An alloy of iron and chromium. Warning: no welding or hot work to be permitted in vicinity.
Ferromanganese	42° to 45°	0.18 to 0.28	Raw material of iron mixed with manganese. Shipment in different sizes between fines and 300 mm.
Ferromanganese exothermic	42° to 45°	0.18 to 0.28	
Fertilizers without Nitrates Non-Hazardous	26° to 50°	0.90 to 1.40	Powder and granular. Size: 1 to 3 mm. Moisture: 0% to less than 1%. Odourless. Greyish/Brown/Beige.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Fly Ash	40°	1.26	Light finely divided powder. Used in commercial products. Diameter: 2 to 3 microns. Residual ash from coal-fired power stations.
Granulated Slag	40°	0.90	Residue of blast furnaces in granulated form. Used by industry. Detrimental if loaded too hot. Size: 0 to 5 mm. Iron: 0.5%.
Gypsum	40° to 50°	0.67 to 0.78	A natural hydrated calcium sulphate. Insoluble in water. Used in cement, tiles, plaster, plate glass, etc. Fine powder to 100 mm. Average moisture: 1 to 2%.
Ilmenite Sand	30° to 38°	0.31 to 0.42	Black sand - average grain size: 100 mesh. Abrasive. From Ilmenite sand is obtained, Monazite, Zircon and Titanium. Cargo should be kept dry. Moisture content 1 to 2%.
Iron Ore	30° to 75°	0.29 to 0.80	Ore. Fines and lumps. Size: Fines to 250 mm. Dusty. Moisture: 0 to 16%
Iron Ore Pellets	27° to 45°	0.24 to 2.53	Ore. Round Pellets. Up to 20 mm. Moisture: 0 to 2%.
Iron Pyrites	37° to 40°	0.40	Iron Sulphide. Used in the manufacture of sulphuric acid. 20% fines; 80% lumps. Size: 30 to 150 mm.
Ironstone	36°	0.39	Ore. Maximum size: 75 mm. Moisture: 1 to 2%.
Labradorite	greater than 35°	0.60	A lime-soda rock form of feldspar. Lumps between 50 and 300 mm.
Lead Ore	30° to 60°	0.24 to 0.67	Powdery. Toxic, with acids evolves highly toxic vapour.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Limestone	34° to 55°	0.67 to 0.84	A sedimentary rock containing calcium carbonate. Lumps: Size 25 to 75 mm. Moisture: Up to 4%.
Magnesite	34° to 45°	0.39 to 0.84	Crystalline carbonate of magnesium. Used for refractory purposes. Powder/fines to lumps. Size: 3 to 30 mm. Odourless. Yellowish. Moisture: none.
Manganese Ore	28° to 60°	0.32 to 0.70	Ore. Fine dust to lumps. Size: smaller than 5 to 250 mm. Moisture: variable, up to 15%.
Milorganite	40° to 45°	1.53	Heat-dried activated sludge. Very fine granular product. Moisture: 3 to 5%. Black speckled colour.
Monommonium Phosphate	36°	1.21	Can be highly corrosive in presence of moisture. Acidity and impurity such as chloride ions in the absence of calcium ions may increase corrosion. Ammonium phosphates with pH greater than 4.5 are essentially non-corrosive. Continuous carriage may have detrimental structural effects over a long period of time.
Muriate of Potash	30° to 47°	0.81 to 1.12	Fertilizer. White crystals. In granular and powder form. Moisture: variable. Iodine odour.
Peanuts (in shell)	50°	3.29	Extremely dusty. Moisture content: variable. Tan colour.
Pebbles (sea)	30°	0.59	Round pebbles: 30 to 110 mm. Roll very easily; should be over-stowed with a layer of sacks.
Pellets (concentrate)	44° to 46°	0.47	Concentrate ore that has been pelletized. Approximately 10 mm. Moisture: Up to 6%.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Perlite Rock	45°	0.98 to 1.06	Claylike and dusty. Moisture: 0.5 to 1%. Light grey. Odourless.
Phosphate defluorinated	30° to 35°	1.12	Granular, similar to fine sand. Moisture: none. Dark grey.
Phosphate Rock (calcined)	28° to 50°	0.64 to 1.26	Mineral, fertilizer. Usually in the form of fine ground rock or prills. Extremely dusty. Hygroscopic and will cake and harden if wet. Keep dry.
Phosphate Rock (uncalcined)	15° to 34°	0.70	An ore with which phosphorous and oxygen are chemically united. Lumps and powder. Low angle of repose after loading, but once settled not liable to shift. Dusty. Moisture: 0 to 2%.
Pig Iron	36°	0.30	High-carbon iron. Size: 80 x 90 x 550 mm.
Potash	32° to 35°	0.77 to 1.03	A carbonate of potassium. Used in fertilizers and soaps. Granular. Moisture: variable to 2%. Brown, pink, white.
Potassium Sulphate	31°	0.90	Hard crystals or powder. Used in aluminium, glass, etc. Colourless or white.
Pumice	45°	1.90 to 3.25	Highly porous rock of volcanic origin. Used as an abrasive. Powder or lumps. Greyish white.
Pyrite	32° to 60°	0.33 to 0.50	Iron disulphide, if cupreous contains copper. Used in the manufacture of sulphuric acid. Fines and lumps. Various sizes from fines to 300 mm. Moisture: 0 to 7%
Pyrophyllite	40°	0.50	A natural hydrous aluminium silicate. Used in ceramics, slate, pencils, etc. 75% lumps; 20% rubble; 5% fines. Chalk white.
Quartz	35°	0.60	Crystalline lumps between 50 and 300 mm.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Quartzite	35° to 40°	0.64	Lumps 10 to 130 mm. Moisture: less than 1%. White, red, brown.
Rasorite 46	37°	0.92	Fine powder and granules; will pass through 8 mesh screen; grey colour; dusty; dust is irritating if inhaled but not toxic. Hygroscopic and will cake if wet. Used as the major source of borax and boron.
Rasorite Anhydrous	40°	0.67 to 0.78	Uniform granular material; will pass through 12 mesh screen; crystalline yellow-white colour; little or no dust; abrasive. Hygroscopic and will cake if wet.
Rutile Sand	33° to 38°	0.39	Fine-particled cargo 60% more than 100 mesh. Abrasive. Material is used for hardening steel. Shipped dry.
Salt	30° to 45°	0.81 to 1.12	Sized: grain fines to 12 mm. Moisture: variable to 5.5%. White.
Salt Cake	30°	0.89 to 0.95	Impure sodium sulphate. Used in ceramic glazes. Granular. Moisture: none. White.
Salt Rock	30°	0.98 to 1.06	Small granules. Moisture: 0.02%. White.
Sand (Foundry) (Quartz) (Silica) (Potassium Feldspar) (Soda Feldspar)	30° to 52°	0.50 to 0.98	Usually fine particled. Abrasive. Used for a variety of purposes including glass and steel-making.
Scrap Metal (see also Ferrous Metal, Appendix B)	45°	varies	Various types of scrap metal, engine blocks, etc.
Silicomanganese	45°	0.18 to 0.26	Sizes from fines to 300 mm. Used as an additive in steel-making process.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Slag Granulated (see Granulated Slag)			
Soda Ash (dense and light)	25° to 45°	1.03 to 1.67	Sodium carbonate. Powdery. Moisture: 0 to 20%. White.
Stainless Steel Grinding Dust	45°	0.42	Caked, 75 to 380 mm lumps. Moisture: 1 to 3%. Brown.
Stone Chippings	55°	0.71	Fines to 25 mm.
Sugar Raw, Raw Brown, Refined White	30° to 39°	1.00 to 1.60	Powdery. Moisture: 0 to 0.05%.
Superphosphate	30° to 40°	0.84 to 1.00	A fertilizer composed of phosphate treated with sulphuric acid. Granular, fines and powdery, up to 0.15 mm in diameter. Moisture: 0 to 7%. Greyish white.
Superphosphate triple granular	29° to 30°	1.17 to 1.23	Fine, free-flowing prills; very dusty. Hygroscopic and will cake and harden if wet. Contains acid and will decompose burlap or canvas cloth.
Taconite Pellets	30°	1.53 to 1.67	Ore. Round iron oxide pellets: approximately 15 mm diameter. Moisture: 2% Grey.
Talc	20° to 45°	0.64 to 0.73	A natural hydrous magnesium silicate. Used in ceramics, electrical insulation, etc. Powdery to lumps 100 mm. Grey colour.
Urea	28° to 45°	1.17 to 1.56	Fertilizer. Form: Granules, beads and prills. Dusty. Diameter: 1 to 3 mm. Moisture: less than 1%.

Material	Approximate angle of repose	Approximate stowage factor m3/t	Properties, observations and special requirements
Vermiculite	36°	1.37	A mineral of the mica group. Used in insulation and fireproofing. Size: approx. 3 mm sq. Average moisture: 6 to 10%. Grey.
White Quartz	42° to 45°	0.61	99.6% Silica content. Lumps varying in size to 150 mm.
Zircon Sand	33° to 38°	0.36	Fine-particled cargo 60% more than 100 mesh. Abrasive. Material is used for hardening steel. Shipped dry.

APPENDIX F

Index of Materials

MATERIALS	APPENDIX	MATERIALS	APPENDIX
Alumina	C	Diammonium Phosphate	C
Alumina Calcined	C	Direct Reduced Iron	B
Alumina Silica	C	Dolomite	C
Alumina Silica pellets	C	Feldspar, lump	C
Aluminum Dross	B	Ferrochrome	C
Aluminium Ferrosilicon	B	Ferrochrome	C
Aluminium Nitrate	B	exothermic	
Aluminium Silicon	B	Ferromanganese	C
Ammonium Sulphate	C	Ferromanganese,	C
Barium Nitrate	B	exothermic	
Barytes	C	Ferrophosphorus	B
Bauxite	C	Ferrosilicon	B
Blende (zinc sulphide)	A	Ferrous Metal	B
Borax Anhydrous	C	Fertilizers	
(Crude or refined)		(see under chemical	
Calcined Clay	C	names)	
(see Alumina Calcined)		Fertilizers, without	C
Calcium Nitrate	B	nitrates, non-hazardous	
Carborundum	C	Fishmeal, Fishscrap	B
Castor Beans	B	Fluorspar	B
Cement	C	Fly Ash	C
Cement Clinkers	C	Foundry Sand	
Chalco Pyrite	A	(see Sand)	
Chamotte	C	Galena (lead)	A
Charcoal	B	Granulated Slag	C
Chilean Natural	B	Gypsum	C
Potassic Nitrate		Ilmenite	A
Chrome Ore	C	('dry' & 'moist')	
Chrome Pellets	C	Ilmenite Sand	C
Clay	C	Iron Ore	C
Coal	A and B	Iron Ore Concentrates	A
Coke (coal origin)	C	Iron Ore (magnetite)	A
Colemanite	C	Iron Ore (pellet feed)	A
Concentrates (ore)	A and B	Iron Ore (sinter feed)	A
Copper Granules	C	Iron Ore Pellets	C
Copper Matte	C	Iron Oxide, spent	B
Copper Nickel	A	Iron Pyrite	A
Copper Ore Concentrate	A and B		
Copper Precipitates	A		
Copra, dry	B		
Cryolite	C		

MATERIALS	APPENDIX	MATERIALS	APPENDIX
Iron Pyrites	C	Petroleum Coke	B
Iron Sponge, spent	B	Phosphate defluorinated	C
Ironstone	C	Phosphate Rock	C
Labradorite	C	(calcined)	
Lead Nitrate	B	Phosphate Rock	C
Lead Ore	C	(uncalcined)	
Lead Ore Concentrate	A	Pig Iron	C
Lead Ore Residue	A	Pitch Prill	B
Lead Silver Ore	A	Potash	C
(particulate)		Potash Muriate	C
Lead Sulphide	A	(see Muriate of Potash)	
Lead Sulphide (galena)	A	Potassium Feldspar Sand	C
Lead and Zinc Calcines	A	(see Sand)	
(mixed)		Potassium Nitrate	B
Lead and Zinc Middlings	A	Potassium Sulphate	C
Lime (unslaked, calcium oxide)	B	Prilled Coal Tar	B
Limestone	C	(See Pitch Prill)	
Magnesite	C	Pumice	C
Magnesium Nitrate	B	Pyrite	C
Magnetite	A	(containing copper and iron)	
Magnetite-Taconite	A	Pyrite	A
Manganese Ore	C	Pyrites (Cupreous)	A
Manganic Concentrate	A	Pyrites (Fine)	A
(manganese)		Pyrites (Flotation)	A
Metal Sulphide Concentrates	A and B	Pyrites (Sulphur)	A
Milorganite	C	Pyritic Ashes (Iron)	A
Monoammonium Phosphate	C	Pyritic Cinders	A
Muriate of Potash	C	Pyrophyllite	C
Nefelin Syenite	A	Quartz	C
(mineral)		Quartz Sand (see Sand)	C
Nickel Ore Concentrate	A	Quartzite	C
Peanuts (in shell)	C	Rasorite 46	C
Pebbles (sea)	C	Rasorite Anhydrous	C
Pellets (concentrate)	C	Rutile Sand	C
Pencil Pitch	B	Salt	C
(See Pitch Prill)		Salt Cake	C
Pentahydrate Crude	A and C	Salt Rock	C
(See Borax)		Sand	C
Perlite Rock	C	(Foundry, Quartz, Silica, Potassium, Feldspar, Soda Feldspar)	

MATERIALS

APPENDIX

MATERIALS

APPENDIX

Sand Ilmenite (see Ilmenite Sand)	C	Taconite Pellets	C
Sand Rutile (See Rutile Sand)	C	Talc	C
Sand Zircon (See Zircon Sand)	C	Tankage	B
Sawdust	B	Tar (See Pitch Prill)	B
Scrap Metal	C	Urea	C
Seed Cake	B	Vanadium Ore	B
Silica Sand (see Sand)	C	Vermiculite	C
Silicomanganese	C	White Quartz	C
Silver Lead Ore Concentrate	A	Woodchips	B
Slag Granulated (see Granulated Slag)	C	Wood Pulp Pellets	B
Slig (iron ore concentrate)	A	Zinc Ashes, Residues, Skimmings, Dross	B
Soda Ash (dense and light)	C	Zinc Ore Concentrate	A
Soda Feldspar Sand (see Sand)	C	Zinc Ore (burnt ore particulate)	A
Sodium Nitrate (Chile saltpetre)	B	Zinc Ore (calamine particulate)	A
Stainless Steel Grinding Dust	C	Zinc Ore (crude particulate)	A
Stone Chippings	C	Zinc and Lead Calcines	A
Sugar (raw, raw brown, refined white)	C	Zinc and Lead Middlings	A
Sulphur	B	Zinc Sinter	A
Superphosphate	C	Zinc Sludge	A
Superphosphate, triple granular	C	Zinc Sulphide (blende)	A
		Zircon Sand	C

- NOTES:** 1 Amendment Service is provided upon specific request only.
2 Addresses whose mail is returned "ADDRESS UNKNOWN" are deleted from the mailing list.
3 This card properly completed will serve as a request for amendment service or as a modification of change of address.
-

Dear Sir;

Please add my name and address as shown on the front of this card to the mailing list for amendments to the 1984 edition of the CODE OF SAFE PRACTICE FOR SOLID BULK CARGOES.

Please change my address from:

Street Address Apt. #
City and Province
Postal Code

to the address shown on the front of this card.

Yours truly,

Signature

-
- NOTES:** 1 Amendment Service is provided upon specific request only.
2 Addresses whose mail is returned "ADDRESS UNKNOWN" are deleted from the mailing list.
3 This card properly completed will serve as a request for amendment service or as a modification of change of address.
-

Dear Sir;

Please add my name and address as shown on the front of this card to the mailing list for amendments to the 1984 edition of the CODE OF SAFE PRACTICE FOR SOLID BULK CARGOES.

Please change my address from:

Street Address Apt. #
City and Province
Postal Code

to the address shown on the front of this card.

Yours truly,

Signature

DATE _____

FROM _____

(Print in Block Letters)

(Street Address)

(City, Province and Postal Code)

TRANSPORT CANADA
CANADIAN COAST GUARD
SHIP SAFETY BRANCH (CGSO-C)
TOWER "A" PLACE DE VILLE
OTTAWA, ONTARIO
K1A 0N7

DATE _____

FROM _____

(Print in Block Letters)

(Street Address)

(City, Province and Postal Code)

TRANSPORT CANADA
CANADIAN COAST GUARD
SHIP SAFETY BRANCH (CGSO-C)
TOWER "A" PLACE DE VILLE
OTTAWA, ONTARIO
K1A 0N7

